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ROCKY MOUNTAIN FRONT RAPTOR SURVEY
DECEMBER 1982 - AUGUST 1984
CONTRACT NO. FWS-6-81-112

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Abstract

A raptor survey was conducted from December 1981 through August 1984, in a 4700 sq km study area on the Rocky Mountain Front, northcentral Montana. The purpose of the study was to gather baseline information on raptor distribution, abundance, habitat use, and productivity to be used to monitor changes in the raptor community brought about by man's activities and to develop protective stipulations. Major activities included oil and gas exploration, timber harvest, livestock grazing, recreation, subdivisions and farming. Nonsystematic ground and aerial surveys were employed, with emphasis on cliff-nesting species.

The golden eagle, northern harrier, prairie falcon, Swainson's hawk, red-tailed hawk, and American kestrel were the most common diurnal species. Estimated nesting densities (pairs per 100 sq. km) were: golden eagle - 0.8, northern harrier - 1.3, red-tailed hawk - 1.2, Swainson's hawk - 1.0, ferruginous hawk - 0.2, and prairie falcon - 1.1.

The great horned owl and northern saw-whet owl were the most commonly encountered nocturnal species. The nesting density of great horned owls was estimated to be 1.0 pairs per 100 sq. km.

The total nesting population density was calculated to be about 447 pairs or 9.5 pairs per 100 sq. km for a total of 18 raptor species. Cliff and riparian habitats were the most important nesting habitats for the raptor community as a whole.

A total of 1,142 raptors was sighted while driving 27546 km of roads, for a total of 41.5 birds sighted per 1000 km driven (18 species sighted).

Suggested management goals were to maintain the healthy and diverse raptor population, and to maintain suitable habitat for possible future reoccupation by nesting bald eagles and peregrine falcons. Stipulations were proposed for the following management categories: 1) Areas occupied by nesting endangered species, 2) potential nesting habitat for endangered species, 3) areas occupied by nesting non-endangered species of special interest (golden eagle, prairie falcon, ferruginous hawk, merlin, northern goshawk), 4) potential nesting habitat for special interest species and other more common species, and 5) areas not used for nesting, including foraging areas.

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I. INTRODUCTION

The Sawtooth Range in northcentral Montana, commonly known as the East Front of the Rocky Mountains, is thought to have a high potential for gas and oil production. Exploration for gas and oil has increased dramatically and undergone a revolution in technology in recent years, and the first commercial gas wells along the East Front went into production in 1982. The East Front also supports an abundant and diverse wildlife resource. Extensive gas and oil development in combination with other land uses such as logging, recreation, and agriculture could cause conflicts with the wildlife resources (Olson 1981, Ihsle 1982, Andryk 1983).

The Interagency Monitoring Program was initiated in 1980 to coordinate data collection on wildlife along the East Front. Agencies involved were the Forest Service (FS), Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), and Montana Department of Fish, Wildlife and Parks (FWP). The specific objectives were to 1) monitor wildlife displacement caused by human activities, 2) monitor wildlife populations to determine changes caused by human activities, and 3) monitor changes in wildlife habitat due to human activities, and the possible effects to wildlife.

A raptor survey was initiated in December 1981 as part of the Interagency Monitoring Program to provide an adequate data base to be used in making responsible management decisions involving development of energy and other resources. Specific objectives were to: 1) determine distribution, abundance and habitat use of the raptor species found on the East Front; 2) describe nesting habitat and productivity of nesting raptors; 3) delineate suitable nesting habitat for the bald eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrinus), regardless of current occupancy; 4) delineate winter concentration areas for bald eagles; 5) determine responses of raptors to human activities, when possible; and 6) develop protective stipulations and guidelines to be used by land management agencies when planning land use activities.

II. STUDY AREA

The study area, located in parts of Teton, Lewis and Clark, and Pondera Counties was bounded on the north by Birch Creek, the south by highway 200, the east by highways 89 and 287, and the west by the boundaries of the Bob Marshall Wilderness area, the Scapegoat Wilderness area, and the Continental Divide (Figure 1). The 4700 sq km study area was divided into three segments. The north segment (1425 sq km) between Birch Creek and the Teton River, was surveyed in 1983. The middle segment (1425 sq km) between the Teton River and the Sun River, was surveyed in 1982. The south segment (1850 sq km) between the Sun River and highway 200, was surveyed in 1984.

Public lands in the study area are managed by the Lewis and Clark National Forest and Helena National Forest (25%), Bureau of Land Management (3%), Montana Department of Fish, Wildlife, and Parks (The Sun River, Ear Mountain, and Blackleaf Game Ranges, totaling 3%), and the Department of State Lands (School Trust Lands - 10%). The remaining 59% is private land. The major land uses are livestock grazing, irrigated and dryland farming, timber harvest, developed and dispersed recreation, and housing developments.

A. VEGETATION AND TOPOGRAPHY

Physical characteristics of various portions of the study area have been previously described in Andryk (1983), Aune and Stivers (1983), DuBois (1983), Erikson (1972), Frisina (1974), Ihle (1982), Joslin (1983), Kasworm (1981), Knight (1970), Mudge (1972a, 1982b), Picton (1960), and Schallenberger (1966).

The study area straddles the eastern edge of the Rocky Mountains, with the eastern two-thirds lying in the Great Plains and the western one-third lying in the Rocky Mountains. The eastern two-thirds is characterized by gently-rolling or flat topography, with elevations ranging from 1158 meters to 1371 meters. Grasslands predominate, traversed by narrow riverine systems. Extensive areas of farmland lie mainly in the eastern one third of the study area. Primary crops are wheat and alfalfa. Nearly all grasslands are grazed by cattle or sheep. Riparian habitats range from mesic grass/shrub coulees to extensive cottonwood forests along the major river bottoms. Major drainages include Birch Creek, Dupuyer Creek, Teton River, Deep Creek, Sun River, Elk Creek, and the Dearborn River.

Figure 1. Raptor study area, Rocky Mountain Front, northcentral Montana.

The western one-third of the study area lies in the Sawtooth Range of the Rocky Mountains, commonly known as the East Front or the Rocky Mountain Front. Topography consists of rugged, parallel ridges formed by thrust-faulting of sedimentary rocks. These ridges have vertical east faces, and moderate to steep west-facing slopes. Spectacular cliffs on the east faces provide abundant nesting habitat for several species of raptors. Most ridge-tops are 2100-2400 meters in elevation, with some peaks reaching up to 2700 meters. Vegetation consists of a complex mosaic of conifer forest, aspen (Populus tremuloides) stands, grassland parks, sparse wind-blown stands of stunted conifer trees, and bare rock. The transition between the rugged Sawtooth Range and flat plains is abrupt, with few foothills.

B. Climate

Climatic conditions vary with elevational ranges and topography. Average annual precipitation varies from 31 cm at Choteau to over 127 cm in the Sawtooth Range. The average growing season varies from 110 days at Choteau to 50 days in the Sawtooth Range north of the Teton River. The mean annual temperature is approximately 5 degrees C, and monthly averages range from minus 6 degrees C in January to 19 degrees C in August. The weather is characterized by strong, southwest winds, especially along the east face of the mountains. The winter and spring months of 1982 averaged colder than normal. This may have influenced the nesting phenology of some of the raptor species. Climatological data for three reporting stations are presented in Appendix A.

III. SUMMARY OF PREVIOUS STUDIES

Six studies dealing with birds of prey had been conducted in or adjacent to the study area prior to the initiation of this study. Schallenberger (1975) conducted a raptor survey on the Lewis and Clark National Forest from April to July 1975. His survey was primarily limited to the eastern edge of the National Forest from the north fork of the Dearborn River to the north end of Walling Reef.

Gramlich (1979) conducted a raptor survey on Bureau of Land Management Lands along the Rocky Mountain Front, from 15 May 1979 to 22 June 1979. Specific areas covered included Steamboat Mountain, Sheep Mountain, Haystack Butte, Swallow Canyon, Cutrock Gorge, Green Timber Gulch, north and south forks of Deep Creek, South Fork Teton Canyon north of Indian Head Rock, and the area between Chicken Coulee and Antelope Butte.

Wenzel (1982) summarized incidental observations of raptors made while conducting other field studies along the Front, between the Dearborn River and Birch Creek. His observations encompassed National Forest, BLM, state, and private lands.

Ellis (1979) conducted a behavioral study on golden eagles in an area adjacent to the study area from 1970 to 1973. Some of his data on nest sites, pesticides, and productivity are applicable to the East Front study area.

Leedy (1972) conducted a study in 1971 and 1972 on the effects of insecticides on prairie falcons. A portion of one of his study areas overlapped the southern half of the East Front study area. His data on prairie falcon productivity and pesticide contamination are applicable to the East Front study area.

Crenshaw (1979) conducted a faunal survey of the Pine Butte Swamp area during 1979. His survey included songbirds, small mammals and furbearers as well as raptors. The portions of the study area covered in these surveys are shown in Appendix B.

IV. METHODS

A. METHODS - VEGETATION

Habitat types on the study area were combined into broad categories, best described as biome types (grassland, riparian, conifer forest, conifer savannah, agricultural farmland, cliff and water). Cliff habitat, though not a vegetational type, was mapped separately because of its importance as raptor nesting habitat. A description of each category is provided in Appendix C, including habitat types described by Mueggler and Stewart (1980) and Pfister et al. (1977).

Habitat categories were delineated on 1:62500 and 1:24000 scale U.S.G.S. topographic maps. U.S. Forest Service P.I. (Photo Interpretation) maps were used to delineate conifer forest stands of greater than 40 percent canopy coverage. The conifer scrub-savannah category included stunted, windblown stands of conifers, scattered large trees, and conifer stands with less than 40 percent canopy coverage. The division was based upon suitability for nesting goshawks (Accipiter gentilis). Conifer stands on non-national forest lands were mapped using aerial photographs. Other habitat categories were mapped using a combination of topographic maps, black and white, color, and color I.R. aerial photos, and land use maps for Teton, Pondera, and Lewis and Clark Counties. Percentages of each type were determined using a dot-grid.

The purpose of the habitat map is to provide information on the general distribution and relative proportions of habitats important to nesting raptors. More specific vegetation information can be obtained from Aune and Stivers (1983), Kasworm (1982) and Andryk (1983).

The linear extent of the major cliffs on the study area was measured to provide a more meaningful measure of availability. Measurements were taken from U.S.G.S. topographic maps. The general aspect of each section of cliff was also recorded.

B. Nesting Surveys

Potential nesting areas for raptors were located by ground reconnaissance and use of aerial photographs and topographic maps. These areas were then searched intensively by helicopter, fixed-wing aircraft, and on foot to locate nests and territories of breeding raptors. Funding was insufficient to allow adequate coverage of the entire study area, so most search effort was directed at cliff-nesting species on BLM and national forest lands. Procedures followed those recommended by Call (1978) Fyfe and Olendorff (1976), Boeker (1970) and White and Sherrod (1973). Information from previous studies and from local residents aided this effort. Active nests were visited near fledging time, if possible, to obtain productivity data.

During ground surveys, nests were checked with a spotting scope, if possible, to avoid disturbing the birds. Nest visits which required a close approach were made during mild weather if eggs or downy young were present.

Pellets and food remains were collected from beneath nests, at perches near nests, and at roosting areas. Most nests were devoid of prey items, resulting in an insufficient sample size for food habits analysis. Therefore, only the occurrence of a prey species in the diet was noted.

Helicopter surveys played a major role in locating cliff-nesting raptors, especially golden eagles (Aquila chrysaetos). An attempt was made to survey all suitable cliffs in the portion of the study area along the East Front at least twice during the nesting season. The first survey was usually conducted in early April, when golden eagles were in the early part of incubation. Surveys conducted later were more likely to miss nests which experienced failure during the incubation or nestling stages. The second survey was usually conducted in mid to late June to obtain brood counts. At this time, most eaglets were nearly full-grown. Adverse weather conditions and scheduling of aircraft delayed some of the surveys, resulting in incomplete data. Golden eagle nests were monitored from the ground when possible, but many nests were either in areas of poor accessibility or on very high cliffs, making reliable ground checks difficult.

Fixed-wing aircraft was used to survey deciduous riparian habitat and grassland habitat for nesting buteos. Appendix D summarizes the number of survey hours using helicopter and fixed-wing aircraft in each year, and Appendix E shows the portions of the study area which were surveyed by air in 1982, 1983 and 1984.

The terms used in this report to describe nesting status generally followed those suggested by Postupalsky (1974). Briefly, they are as follows:

Occupied - pair present, nesting suspected but not confirmed.

Active - confirmed nesting attempt (incubation, eggs, or young observed).

Nest failed - nesting attempt terminated before young could be fledged.

Young produced - young observed in nest, fledging not confirmed.

Young fledged - young observed to have fledged. Young which were close to fledging-age (completely feathered-out and full-sized), but still in the nest were counted as fledged.

C. GREAT HORNED OWL SURVEYS

Nesting great horned owls (Bubo virginianus) were surveyed in 1983 using a method similar to one described by Youmans et al. (1981). Four survey routes were set up, one each in conifer forest, conifer scrub-savannah, grassland, and deciduous tree riparian habitats. Each route was 5 miles (8 km) long with 10 stops placed at 0.5 mile (.8 km) intervals. Taped great horned owl vocalizations were played for approximately one minute. The number of owls responding to the taped calls, gender, and approximate distance and direction (to aid in distinguishing previously-counted individuals) were recorded. Each survey route was conducted once between mid-February and early April on clear, windless nights. Each survey route took about three hours to complete.

D. BALD EAGLE WINTER SURVEYS

Limited aerial and ground surveys were conducted during the winter to locate bald eagle winter concentration areas. Some of the surveys were conducted in conjunction with the mid-winter bald eagle survey, coordinated by the Raptor Information Center of the National Wildlife Federation.

E. ROAD SURVEYS

Location, activity, and habitat were recorded for all birds of prey observed while driving, to provide an index of abundance which can be compared to other areas (Woffinden and Murphy 1977, Craig 1978). This information was gathered peripheral to other activities, so different times of the day and different weather conditions were encountered. Results were summarized as number per 1000 miles and 1000 km traveled.

V. RESULTS

A. VEGETATION

The percentages of each habitat in the study area are presented in Table 1. Grasslands were the most extensive type, covering about half of the study area. Cliffs covered about one percent of the study area. The distribution of habitats in the study area is shown in Appendix F.

Table 1. Percentages of each habitat in the 4700 square km Rocky Mountain Front study area, northcentral Montana.

Habitat	Percent
Grassland	47
Conifer savannah	25
Agricultural	11
Conifer forest	10
Riparian	4
Water	1
Cliff	1

Approximately 316 km of cliffs were present in the study area. The majority of cliffs were in the Sawtooth Range in the western one-third of the study area. Directional exposure of the cliffs is shown in Figure 2. The majority of cliffs faced east or northeast.

Figure 2. Directional exposure of cliffs located in the Rocky Mountain Front study area, northcentral Montana.

B. NESTING SURVEYS

1. DIURNAL RAPTORS

Eighteen species of diurnal raptors were observed during the study or reported by reliable observers (Appendix G). Twelve species were either suspected or confirmed to be nesting within the study area. The most common nesting species were the golden eagle, northern harrier (Circus cyaneas), prairie falcon (Falco mexicanus), American kestrel (Falco sparverias), red-tailed hawk (Buteo jamaicensis) and Swainson's hawk (Buteo swainsonii).

The bald eagle (Haliaeetus leucocephalus) and rough-legged hawk (Buteo lagopus) were present as both migrants and winter residents. A pair of broad-winged hawks (Buteo platypterus) observed in fall 1982 were considered to be accidental migrants in the study area. They are rarely reported in Montana (Skaar 1980).

GOLDEN EAGLE (Aquila chrysaeros)

The golden eagle was a common nesting species in the study area. Breeding birds were suspected to be nonmigratory, although some movement to lower elevations in winter was probable.

A total of 123 golden eagle nests was found in and adjacent to the study area, most of which were alternate nests for about 37 nesting pairs. Many of the nests were located in groups of up to seven nests on a single cliff. Ninety-seven percent (119 nests) were on cliffs and three percent (3 nests) were in trees (Table 2). The percentage of tree nests may be underestimated due to the difficulty of locating nests in conifer trees and the concentration of search effort on cliffs.

Table 2. Nest supports used by seven species of raptors on the Rocky Mountain Front, northcentral Montana, 1982-1984.

	Total Number Of Nests	Percentages of nests in each type					
		Ground	Cliff	Deciduous Shrub	Deciduous Tree	Conifer Tree	Abandoned Building
Golden Eagle	122		97		1	2	
Red-Tailed Hawk	20		20		80		
Swainson's Hawk	32			31	69		
Ferruginous Hawk	33	79	21				
Prairie Falcon	55		100				
Great Horned Owl	11		18	9	64		9
Merlin	4				25	75	

Golden eagle nests ranged in elevation from 1250 m to 2386 m, with 73% between 1524 m (5000 ft.) and 2103 m (6900 ft.). Twenty percent were located at or above 2133 m (7000 ft) elevation (Appendix H).

The majority of golden eagle nests had east or northeast exposures (Figure 3). The directional exposure of 109 golden eagle nests located on cliffs within the study area boundaries was compared to the directional exposure of cliffs located within the study area using the Chi-square test. East, northeast, and southeast exposures were treated separately and all other exposure categories were lumped together due to small expected values (Hoel 1966). The difference between the golden eagle nest exposures and available cliff exposures was not significant (d.f. = 3, $\chi^2 = 3.255$, $p = 0.3$). This differs from the findings of Mosher and White (1976) who found that nest exposure in a given region was selected on the basis of the thermoregulation needs of the young. Baglien (1975) found that south and east exposures were favored by golden eagles in southwestern Montana. He felt that major downdraft areas (the lee side of ridges interrupting prevailing winds) were unsuitable for golden eagle nesting. This proved not to be the case on the East Front, where most nests were on northeast and east aspects where the strong prevailing southwest winds should have created strong downdrafts. Menkens (1983) concluded that physical characteristics of golden eagle nest sites in trees did not differ significantly from availability in N.E. Wyoming.

Figure 3. Directional exposure of golden eagle nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

Most of the cliffs used by nesting golden eagles were located in the Sawtooth Range in the western one-third of the study area. Cliff heights (Appendix H) ranged from 6 m to 244 m (mean 67 m) and nest heights ranged from 4.6 m to 152 m (mean 38 m). Percent height (nest height divided by cliff height times 100) ranged from 12% to 92% (mean 58%). Conifer forest and conifer savannah were the predominant habitats surrounding cliffs used for nesting.

The number of golden eagle young fledged per successful nest (Table 3) was 1.4 young in 1982 (10 nests), 1.25 young in 1983 (12 nests), and 1.25 in 1984 (4 nests). One nest in 1982, three nests in 1983, and 1 nest in 1984 were known to have failed. Several nests have been in use at least since 1975 (Schallenger 1975). Nesting chronology is presented in Table 4.

Table 3. Average number of young fledged per successful nest for eight raptor species on the Rocky Mountain Front, northcentral Montana, 1982-1984.

Species	1982		1983		1984	
	No. of nests	No. of young per nest	No. of nests	No. of young per nest	No. of nests	No. of young per nest
Golden Eagle	10	1.4	12	1.25	4	1.25
Northern Goshawk	1	2	1	1	1	2
Red-Tailed Hawk	4	1.75	7	1.86	4	2.5
Swainson's Hawk	6	1.67	9	2.11	1	2
Ferruginous Hawk	3	3	2	3	-	-
Prairie Falcon	5	3.2	8	3.8	2	4.5
Great Horned Owl	2	2	8	2	1	2
Merlin	-	-	1	4	1	3

Table 4. Nesting chronology observed for six raptor species on the Rocky Mountain Front, northcentral Montana, 1982-1984.

	Initiation of Courtship	Start of Incubation	Hatching	Fledging
Golden Eagle	December	3/ 3 - 4/ 6	4/14 - 5/18	6/23 - 7/28
Red-tailed Hawk	March	4/26 - 5/ 4	5/26 - 6/12	7/10 - 7/26
Swainson's Hawk	May	5/ 7 - 7/ 2	6/ 7 - 8/ 6	7/15 - 9/10
Ferruginous Hawk	April	4/16 - 5/12	5/16 - 6/10	7/ 5 - 7/25
Prairie Falcon	March	4/13 - 5/19	5/13 - 6/19	6/20 - 7/27
Great Horned Owl	February	2/11 - 3/ 1	3/18 - 4/ 5	5/20 - 6/ 7

Few prey items were found around nests, but eagles were commonly observed carrying jackrabbits and ground squirrels (Appendix I). Carrion from road kills, winter-killed big game, and dead stock were other food sources, especially in winter. Principal prey species from other studies included white-tailed jackrabbits (Lepus townsendii) and deer fawns (Odocoileus spp.) (Becker 1982), white-tailed jackrabbits and cottontail rabbits (Sylvilagus spp.) (McGahan 1968), cottontail rabbits, prairie dogs (Cynomys ludovicianus) and black-billed magpies (Pica pica) (Lockhart 1976; Lockhart et al. 1977), white-tailed jackrabbits (Woodgerd 1952), and jackrabbits (L. townsendii) and ground squirrels (Spermophilus spp.) (Baglien 1975).

Cliff habitat only covered 1% of the study area, yet was used for nesting by 35 pairs of golden eagles (94% of the pairs found nesting on the study area). Linear distance is probably a more meaningful measure of cliff availability. Approximately 316 km of cliffs were available in the study area. This yields about 9 km of cliff per nesting pair.

Thirty-seven pairs of golden eagles were found nesting in the study area (two pairs located greater than one km outside the study area boundary were not counted in density estimates). This yields a minimum density of 0.8 pairs per 100 sq km.

BALD EAGLE (Haliaeetus leucocephalus)

No nesting bald eagles were found during the study, although two historic nest sites were reported by local residents on Elk Creek and the Sun River (Schallenberger 1975, L. Young pers. comm.). Both nests were occupied until the mid to late 1950's.

Nesting bald eagles require large conifer or deciduous trees which are fairly close (usually within 1.6 km) to large bodies of water (Anthony et al. 1982). Within the study area, Birch Creek, Teton River, Sun River, Elk Creek, and the North Fork Dearborn River were all considered to be suitable nesting areas. Birch Creek has Swift Reservoir and many small, natural lakes for foraging areas and conifer forests for nesting. The Teton River contains a poor fishery due to floods in 1964 and 1975, but is very close to Bynum Reservoir and Eureka Reservoir which both contain adequate fish populations. Heavy recreational use of these reservoirs may preclude bald eagle use. Gibson Reservoir, Willow Creek Reservoir, Pishkun Reservoir, and numerous ponds and marshes supplement the foraging habitat for bald eagles along the Sun River and Elk Creek. The North Fork Dearborn River is close to Bean Lake and many smaller lakes. Heavy recreational use of some reservoirs may preclude bald eagle use, especially during periods of peak recreational use. All of the mentioned rivers and creeks have segments that are isolated from human activity centers such as roads, campgrounds, houses, and agricultural fields. These areas will remain suitable for nesting bald eagles as long as these disturbance-free segments remain.

NORTHERN HARRIER (Circus cyaneus)

The northern harrier was one of the most abundant nesting raptor species on the study area. The breeding population was migratory, being on the study area from March through October. Northern harriers occupied grassland, agricultural and riparian habitats throughout the eastern half of the study area.

One nest containing three young and two eggs was found at the edge of a hayfield by a ranch hand while mowing the hay. Although he did not mow over the nest, it was later destroyed by predators. Other ranchers also reported encountering harrier nests in hayfields. Mesic grass-sedge or shrub coulees probably were also used by harriers for nesting. Harriers typically nest on the ground in tall, dense grass or low shrubs found in moist coulees, marshes or creek bottoms (Becker 1982, Terres 1980, Call 1978). Such areas were interspersed with xeric grasslands and agricultural land in the study area. Little effort was spent searching for harrier nests, although fledged young were observed on numerous occasions. At least 85 pairs were observed in the 4700 km study area, yielding a minimum density of 1.8 pairs per 100 sq km.

NORTHERN GOSHAWK (Accipiter gentilis)

The northern goshawk was present on the study area as a summer resident and rare winter resident. Goshawks were sighted infrequently compared to most other species, but this may indicate low observability rather than a low population. Nesting was confirmed three times, with the observation of fledged young in 1982, a nest in 1983, and fledged young in 1984. A nest was also found by Crenshaw (1979) approximately 400 m from the 1983 nest site. Both nests were located in mature Douglas-fir (Pseudotsuga menziesii) - Lodgepole pine (Pinus contorta) stands on a north-facing slope. Both nests were at an elevation of about 1600 m. Shuster (1980) found that most goshawk nests in Colorado were on slopes with north to east aspects. Goshawks in Oregon preferred dense, mature conifer stands on gentle slopes with northwest to northeast exposure for nesting (Reynolds et al. 1982). Hayward (1983) characterized typical goshawk nesting habitat within the western portion of Region 1 National Forests as mature to overmature conifer forest with a closed canopy on a moderate north-facing slope, usually at or near the bottom of the hillside.

Conifer forest suitable for nesting goshawks only covered about ten percent of the study area (Table 1), and was limited to the Sawtooth Range in the western one third of the study area (Appendix F). Most of the suitable conifer forests occurred in the area south of the Sun River. Goshawks on the study area appeared to initiate nesting activities in late April or early May and fledge young in late July. Huhtala and Sulkava (1981) found that the onset of nest-building by goshawks in Finland was correlated with the mean monthly temperatures in spring.

Goshawks in North America generally initiate nesting in April (Jones 1979). Huhtala and Sulkava (1981) also reported poor nesting with many unoccupied nests and smaller clutches after a very cold winter.

Goshawks are usually absent from breeding areas for five to six months (Jones 1979). Some populations migrate, while others exhibit localized wanderings. Goshawks were sighted along the Teton River just west of Choteau during winter. It is not known whether these were "local" birds from the Sawtooth Range or migratory birds from other regions.

A population estimate for the goshawk was not attempted due to lack of data. The population is suspected to be fairly low, mainly due to the lack of suitable nesting habitat in the study area.

RED-TAILED HAWK (Buteo jamaicensis)

The red-tailed hawk was a common nesting species on the study area. The breeding population was migratory, being present on the study area from March through October.

Nesting red-tailed hawks were mainly associated with riparian habitat in the eastern half of the study area. Eighty percent of the twenty nests located were in cottonwood trees (Populus spp.), and the remainder were on cliffs (Table 2). Wenzel (1982) found an active red-tailed hawk nest in a juniper (Juniperus spp.) tree adjacent to riparian habitat in the northern part of the study area in 1980. This area was occupied by a pair of red-tailed hawks in 1983, but the nest was not located. Red-tailed hawk nests in conifer trees were more difficult to locate, and little time was spent searching conifer habitat, so use of this type was probably underestimated.

Red-tailed hawk nest elevations ranged from 1200 m to 1829 m (Appendix J). All cottonwood nests were in trees greater than 6 m tall. The average nest height above the ground was higher for red-tailed hawks (7.1 m) than for Swainson's hawks (4.6 m). Gilmer et al. (1983) reported that red-tailed hawk nests were significantly higher than other buteo nests in central North Dakota. Schmutz et al. (1980) also found that red-tailed hawk nests tended to be higher than Swainson's Hawk nests, and suggested that use of different nest heights reduced competition between the species.

Red-tailed hawk nests in the study area tended to be located in clusters which were associated with riparian systems. This uneven distribution may be partially due to uneven coverage of the study area, although most of the large expanses of grassland habitat in the study area are lacking in suitable nest sites for red-tailed hawks. Gilmer et al. (1983) also reported a clumped distribution of red-tailed hawk nests, associated with wooded drainages. Schmutz et al. (1980) found that red-tailed hawks in southeastern Alberta tended to be more common in areas with more aspen timber and ponds. Gaines and Kohn (1982) also concluded that riparian areas were important nesting habitat for red-tailed hawks in Central North Dakota.

Riparian habitat only covers 4% of the study area, yet it was the most important nesting habitat for red-tailed hawks. Areas mapped as riparian habitat included riparian types which were unsuitable nesting habitat for red-tailed hawks (shrub and grass-sedge communities), therefore the actual amount of suitable nesting habitat was smaller than reported. Large areas of conifer forest, conifer scrub-savannah, and cliff habitats which are also considered suitable nesting habitat for red-tailed hawks, are found in the Sawtooth Range in the western portion of the study area. These areas seemed to be sparsely occupied by red-tailed hawks so other environmental factors (prey base, length of growing season, etc.) were believed to be limiting. A more intensive study would be necessary to delineate suitable nesting areas for red-tailed hawks in these habitats.

The number of young fledged per successful nest (Table 3) was 1.75 in 1982 (four nests), 1.86 in 1983 (seven nests), and 2.5 in 1984 (four nests). This was slightly higher than fledging rates reported by Gilmer et. al (1983), and about the same as that reported by Peterson (1979) for southeastern Wisconsin. Nesting chronology for the study area is shown in Table 4.

The few observations of prey items indicated that red-tailed hawks in the study area fed on voles (Microtus spp.) and ground squirrels. Red-tailed hawks are known to feed on a wide variety of prey, and are not as dependent upon the abundance of one or two prey species as are prairie falcons and golden eagles (U.S.D.I. Bureau of Land Management, 1979). Seidensticker (1970) found that red-tailed hawks in southcentral Montana preyed on 28 species of mammals, birds, reptiles, and fish. Mammals, primarily Richardson's ground squirrels (Spermophilis richardsonii), cottontail rabbits (Sylvilagus spp.) and voles comprised 70% of their diet. Uinta ground squirrels (S. armatus) and voles made up the majority of the diet of red-tailed hawks in Wyoming (Craighead and Craighead 1956).

The riparian habitat used for nesting by red-tailed hawks was often adjacent to agricultural areas. Seidensticker and Reynolds (1971) found low levels of pesticide contamination and some eggshell thinning in red-tailed hawks in southcentral Montana, but they concluded that disturbance by man was more significant in causing nest failures than pesticides.

The number of nesting pairs of red-tailed hawks was estimated to be about 57 pairs. This yields a nesting density of 1.2 pairs per 100 sq km for the study area.

SWAINSON'S HAWK (Buteo swainsoni)

The Swainson's hawk was a common nesting species on the study area. The breeding population was migratory, being present on the study area from April through September.

Nesting Swainson's hawks were associated with riparian habitat in the eastern half of the study area. Thirty-two nests (including alternates) were located in or adjacent to the study area during the study. All Swainson's hawk nests were in deciduous trees or shrubs (Table 2), with cottonwood used most frequently (69%). Trees and shrubs used for nesting by Swainson's hawks tended to be smaller (average height = 6.2 m) than those used by nesting red-tailed hawks (average height = 10.6 m). Swainson's hawk nest heights were also lower than red-tailed nest heights, but the two species build their nests at about the same level within the nest trees (percent height equals nest height divided by substrate height times 100 = 71% for red-tailed hawks and 74% for Swainson's hawks). Gilmer et al. (1983) and Schmutz et al. (1980) both reported that Swainson's hawk nest heights were lower than red-tailed hawk nest sites. Nest elevations ranged from 1152 m to 1378 m (Appendix K). Four nests (12%) were in shelterbelts at abandoned homestead sites, and the others were in native riparian vegetation in creek bottoms and coulees. Swainson's hawks also nested in shelter belts and creek bottoms in central North Dakota (Gilmer et al. 1983, Gaines and Kohn 1983), southeastern Alberta (Schmutz et al., 1980), and California (Bloom 1980), but primarily nested in juniper in the Great Basin Desert of Utah (Smith and Murphy 1982b).

Riparian habitat only covers 4% of the study area, yet it was used by most of the nesting Swainson's hawks. It is possible that a few nests were overlooked in conifer scrub-savannah habitat, but sightings of Swainson's hawks did not indicate much use of this habitat.

The number of young fledged per successful nest was 1.67 in 1982 (six nests), 2.11 in 1983 (nine nests), and 2.0 in 1984 (one nest). This compares favorably with 2.0 for southeastern Alberta (Schmutz et al. 1982) and 2.27 for California (Bloom 1980). Swainson's hawks were later in nesting phenology than other raptor species on the study area (Table 4). Schmutz et al. (1982) found that Swainson's hawks were more susceptible to reduced fledging success than red-tailed hawks or ferruginous hawks when food shortages occurred, because Swainson's hawk young fledged when the ground squirrel population was past its peak and declining. Ferruginous hawk and red-tailed hawk fledging coincided with the peak of the ground squirrel population.

Swainson's hawks fed on a wide variety of small birds and mammals (Appendix I). An insufficient sample of prey items precluded calculations of percentages, so only the occurrence of prey in the diet is noted. Schmutz et al. (1982) calculated the dietary overlap (based on biomass) between Swainson's hawks and ferruginous hawks to be 82% and 98% for the two years of study. Gilmer et al. (1983) reported a 40% dietary overlap between Swainson's hawks and red-tailed hawks, based on percentage of occurrence.

The number of nesting pairs of Swainson's hawks was estimated to be about 45 pairs. This yields a nesting density of 1.0 pairs per 100 sq km for the study area.

FERRUGINOUS HAWK (Buteo regalis)

The ferruginous hawk was an uncommon summer resident in the grasslands of the eastern half of the study area. The breeding population was migratory, being present on the study area from April through September. Thirty-three nests were found in the study area, most of which were alternate nests for about ten breeding pairs. Nests were in clusters of up to nine nests in the same area. Seven nests (21%) were on small sandstone cliffs, and the remainder were on the ground, usually on steep, eroded hillsides (Table 2). Nest elevations (Appendix L) ranged from 1225 m to 1414 m (mean = 1301 m). Most nests faced north or west (Figure 4).

Figure 4. Directional exposure of ferruginous hawk nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

All ferruginous hawk nests were originally built in grassland habitat. Most of the surrounding habitat around two nests was converted to dryland farming during 1982, when over 3000 acres (12.1 sq km) of native prairie were plowed. Neither nest was active in 1982 or 1983. Although grasslands cover 47% of the study area, only areas with steep ridges or cliffs were used for nesting by ferruginous hawks.

Jasikoff (1982) concluded that ferruginous hawks avoid pure grassland areas with no trees. In most of the studies he cited, ferruginous hawks nested primarily in trees. On the East Front, large tracts of native grassland containing rugged topography (steep hillsides and ridges) were the primary requirements for the ferruginous hawk. Lokemoen and Duebbert (1976) found that ferruginous hawk nests were located farther away from human disturbance than randomly-selected points. Most of the nests on the East Front were located out of sight of roads or inhabited buildings.

Fledging success was three young per successful nest in both 1982 (three nests) and 1983 (two nests). Three nests failed in both 1982 and 1983. Production data were not obtained in 1984. The productivity of ferruginous hawks is thought to be related to prey abundance (Snow 1974a). Nesting chronology is shown in Table 4.

Prey remains from nests included ground squirrels and jackrabbits (Appendix I). Ferruginous hawks have been reported to prey on a wide variety of mammals and birds, although their diet is generally less diverse than red-tailed hawks (Snow 1974a).

MERLIN (Falco columbarius)

The merlin was a rare summer resident on the study area. Three nests were reported in the study area by Crenshaw (1979) and Wenzel (1982). One of the sites was apparently not used in 1982, although merlins were sighted about 2 km north of the nest site. They may have had an alternate nest site which was not located. This site fledged four young in 1983. Nesting was not confirmed at the other two sites during this study. An additional nest was found during 1984, which fledged three young. All four merlin nests were in abandoned black-billed magpie (Pica pica) nests, three in limber pines (Pinus flexilis), and one in cottonwood (Populus spp.) in riparian habitat. Ellis (1976) reported finding merlin nests only in conifer trees in northcentral Montana, but merlins nested in shelterbelts and riparian habitat on the Canadian prairies (Fox 1964, Hodson 1976). The presence of abandoned corvid nests is more important than the tree species (Trimble 1975).

The merlin is thought to be fairly rare in Montana, compared to other regions, and the population may be declining (Trimble 1975). The Richardson's merlin has suffered population declines over much of its range due to pesticides and habitat destruction (Fox 1971, Hodson 1976, Trimble 1975). Suitable nesting habitat for merlins in the study area (conifer savannah, riparian habitat, shelterbelts) appeared to be largely unoccupied by merlins. No population estimate was attempted for merlins because of the lack of data.

PRAIRIE FALCON (Falco mexicanus)

The prairie falcon was a common nesting species in the study area. The breeding population nested mainly in the Sawtooth Range in the western half of the study area. Prairie falcons were rarely observed on the study area during winter.

Prairie falcon aeries were difficult to locate due to the lack of a visible nest structure (Snow 1974b) and the large height and extent of the cliffs to be searched. Helicopter surveys were inefficient, detecting no more than half of the nesting pairs present on any given flight. Many hours of ground observation were usually required to locate aeries. Therefore emphasis was placed on determining occupancy of a cliff by prairie falcons rather than locating each aerie.

Fifty-seven pairs of prairie falcons were found during the study, of which 55 were in the study area or within one km of the boundary, and two were about 8.8 km north of the study area boundary. It is estimated that only one-half to one-third of the prairie falcon pairs on the study area was found.

All prairie falcon aeries were located on cliffs which ranged in height from 6 m to 183 m (mean = 79 m). Approximate nest elevations (Appendix M) ranged from 1244 m to 2317 m (mean = 1901 m). Directional exposure of the 35 occupied cliffs is shown in Figure 5. The majority of cliffs faced northeast or east. Directional exposure of 54 occupied cliffs located within the study area boundary was compared to the exposure of available cliffs using the Chi-square test. East, northeast and southeast exposures were treated separately and all other exposure categories were lumped together due to small expected values (Hoel 1966). The difference between prairie falcon nest cliff exposures and available cliff exposures was not significant ($d.f. = 3$, $\chi^2 = 3.148$, $p = .30$). Leedy (1972) also found that prairie falcons selected nest exposures on the basis of availability.

Figure 5. Directional exposure of prairie falcon nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

The number of young fledged per successful nest (Table 3) was 3.2 in 1982 (five nests), 3.8 in 1983 (eight nests), and 4.5 in 1984 (two nests). Other aeries were known to have fledged young, but accurate counts were not made. The contents of most aeries were not visible from either the ground or aircraft, so fledging counts usually could only be made after fledging had taken place. Fledged prairie falcons dispersed rather rapidly from the nest vicinity making accurate counts difficult to obtain. Two aeries were known to have failed in 1983 from unknown causes. Reoccupancy of nesting cliffs from year to year was high. Ten of eleven occupied cliffs from 1982 were occupied in 1983, and one cliff was not checked. Three cliffs have been occupied at least since 1975.

Prairie falcons arrived at the nest sites starting in early March (Table 4). Egg-laying was initiated in April. Leedy (1972) reported a similar phenology for prairie falcons nesting in an area adjacent to the study area. Leedy (1972) compared pesticide levels and reproductive success in an area adjacent to the study area with two other regions in Montana. Prairie falcons in this area generally had lower pesticide contamination and higher reproduction rates than those in an area west of the Continental Divide. Prey remains noted at nests in the study area are listed in Appendix I. Prairie falcons are known to feed on a wide variety of birds and mammals, but usually prey heavily on the most abundant available prey (Becker 1982, U.S.D.I. Bureau of Land Management 1979, Leedy 1972, Porter and White 1973, Enderson 1964). Various species of ground squirrels were key prey species for prairie falcons in most of the above-mentioned studies.

Cliff habitat only covered 1% of the study area, yet was used by 100% of the prairie falcons for nesting. Linear distance is probably a more meaningful measure of cliff availability. Approximately 316 km of cliffs were available in the study area. This yields about 6.1 km of cliff per nesting pair (52 nesting pairs). The prairie falcon population density (based on 30 known pairs) was about 1.1 pairs per 100 sq km or one pair per 90 sq km.

PEREGRINE FALCON (Falco peregrinus)

No peregrine falcons were observed during the study, although two sightings of migrating peregrines were reported by other observers (L. Young, pers. comm.; W. Elliot, pers. comm.). It is probable that the peregrine falcon nested in the study area prior to the population decline brought about by organochlorine pesticides. Enderson (1969) estimated the population in the northern Rocky Mountains to be less than one pair per 5,000 square miles in 1964 and 1965.

Within the arid western states, the peregrine falcon generally breeds near rivers or lakes where shorebird, waterfowl, and songbird populations tend to be high, and where prey is vulnerable to attack over water (Enderson 1969, Porter and White 1973). Nelson (1969) speculated that reduced precipitation and higher temperatures since 1870 may have caused a small decline of peregrine populations by causing lower water levels in lakes and ponds, which reduced the populations of shorebirds. He felt this may have improved habitat conditions at higher elevations and above 50° north latitude. His theory remains conjectural. Snow (1972) reported that increasing development of the west had resulted in loss of habitat and lower peregrine populations. Neither climatic changes or habitat changes caused the large scale population declines. Organochlorine pesticides are believed to have been the major cause (Snow 1972, Ratcliffe 1980). As a result, large expanses of suitable habitat remain unoccupied, and habitat deterioration is not presently the major factor limiting peregrine populations (Snow 1972). Peregrine populations in some areas have started to recover (Ratcliffe 1980). Protection of suitable habitat is necessary to allow expansion of peregrine populations back into previously occupied areas.

Peregrines tend to choose higher cliffs usually associated with lake or river (riparian) habitats, for nesting, and higher sites on the cliff than do prairie falcons (Porter and White 1973), although nests have been found on small cliffs, steep river banks, and in hollow trees (Bent 1938). Several historic peregrine nests were located on steep banks along the Milk River in Montana (Flath, pers. comm.). Distances from aeries to hunting areas ranged from 0.31 km. to 15.6 km. in Utah (Porter and White 1973).

Bond (1946) reported that few peregrine nests were found above 1524 m (5000 ft.) elevation. In California, 11% of the cliffs occupied by peregrines were between 5000 and 5999 feet and none were above 6000 feet elevation (Boyce and White 1979). The majority of peregrine aeries in Colorado were above 6000 feet (1829 m) and one was at an elevation of 12000 feet (Porter and White 1973). There is little information on what factors may prevent peregrines from nesting above certain elevations, but Cade (Pers. comm.) thought that elevations suitable for nesting prairie falcons would probably be suitable for nesting peregrines.

Ellis (1982) rated cliffs for suitability for nesting peregrines in Arizona on the basis of height, extent, surrounding habitat, distance to water, and prominence. Nearly all of the cliffs in the East Front study area would rate good to excellent under this system (DuBois 1983). The cliffs on the East Front considered to be the best peregrine habitat were those which were close to extensive riparian habitat (within 5 km), over 50 m in height and one km in extent, with numerous nesting ledges, and the majority of the cliff under 2300 m elevation. Cliffs meeting these requirements included the Castle Reef - Diversion Dam area, South

Fork Willow Creek, South Fork Teton Cliff, Wind Mountain, Muddy Creek and Blackleaf Creek Canyons, Rinker Creek, North and South Forks Dupuyer Creek, the northern portion of Walling Reef and Split Mountain areas, Heart Butte, Cutrock Creek, and the Dearborn River Canyon.

2. NOCTURNAL RAPTORS

Six species of owls were observed on the study area during the study (Appendix G): the great horned owl, short-eared owl (Asio flammeus), great gray owl (Strix nebulosa), northern saw-whet owl (Aegolius acadicus), western screech-owl (Otus kennicottii), and eastern screech owl (Otus asio). Four additional species have been reported by other observers: the snowy owl (Nyctea scandiaca), burrowing owl (Athene cunicularia), northern pygmy-owl (Glaucidium gnoma), and long-eared owl (Asio otus).

GREAT HORNED OWL (Bubo virginianus)

The great horned owl was a common year-long resident in the study area. Eleven nests were located during the study. Two nests were on cliffs, eight were in deciduous trees or shrubs, and one was in an abandoned barn (Table 2). Nine of the nests (the barn nest and tree nests) were abandoned corvid or buteo nests. Nest heights ranged from 2.1 m to 9.1 m (Appendix N). Trampling by the young destroyed three of the nests by fledging time. Nero (1980) also reported this behavior for great gray owls.

Fledging success (Table 3) was two young per successful nest in both 1982 (two nests), 1983 (eight nests), and 1984 (1 nest). One nest failed in the incubation stage in 1983, possibly due to a snowstorm. Great horned owls initiate nesting much earlier than other species of raptors (Table 4).

Most great horned owl nests were located in riparian habitat. Riparian habitat was present below both of the cliff nests, and approximately one km from the barn nest. It is likely that riparian habitat supported greater densities of prey species than other habitats.

Two of the stick nests were believed to have been abandoned buteo nests, and the other six corvid nests. Gilmer et al. (1983) found that great horned owls in North Dakota used nests built by different species in proportion to their availability. The total number of pairs of great horned owls in the study area was at least 46. This yields a minimum density of 1.0 pairs per 100 sq km. The actual population of great horned owls was probably much higher than this.

BARRED OWL (Strix varia)

Two barred owl sightings were recorded for the study area. One was a road kill found near Bowmans Corners at the south edge of the study area (P.D. Skaar, pers. comm.). The other was a fall sighting of an adult bird near Gibson Reservoir (R. Escano, pers. comm.). Barred owls are probably only accidental east of the Continental Divide in Montana. No habitat in the study area was thought to be suitable for nesting barred owls.

C. GREAT HORNED OWL HOOTING SURVEYS

The results of the great horned owl survey routes are shown in Table 5. The highest number of pairs were found on the conifer savannah route, however most of those pairs were actually in a riparian area which was adjacent to the conifer savannah habitat being sampled. It appears as though riparian habitat supported more owls than grassland or conifer forest habitat, although further testing would be necessary to determine actual differences between the habitats. The method has not yet been tested to determine reliability of response rates by great horned owls, however there are plans to do so (Youmans, pers. comm.).

Table 5. Numbers of great horned owls detected along hooting survey routes in four habitats along the Rocky Mountain Front, northcentral Montana, 1983.

HABITAT	NO. PAIRS	NO. PAIRS PER STOP	NO. PAIRS PER KM
Grassland	1	0.1	0.125
Conifer Savannah	7	0.7	0.875
Conifer Forest	2	0.2	0.25
Riparian	6	0.6	0.75

D. BALD EAGLE WINTER SURVEYS

The bald eagle was present on the study area from September through April as an uncommon winter resident and migrant. The wintering bald eagle population was estimated to be about 15 birds on the Sun River near Augusta and five birds on the Teton River near Choteau during the winter of 1981-82. Few bald eagles were observed during the winters of 1982-83 and 1983-84, possibly due to weather factors and fewer hours of observation in the field. The 1983 mid-winter bald eagle survey for Montana showed a slight increase over 1982 (Flath 1983).

The distribution of wintering bald eagles in the study area was influenced by the amount and location of open water. During extended periods of extreme cold, bald eagles were concentrated around the few areas of open water. At least two of these "core" wintering areas were located in the study area: 1) Elk Creek and the Sun River near Augusta and 2) the Teton River from Choteau to the Tetonview School west of Choteau. Other core wintering areas probably existed on the North Fork Dearborn River and possibly other drainages, but these areas were not searched during periods of cold weather.

During mild weather, open water was widely available and bald eagles dispersed along all the major waterways. Other food sources utilized by bald eagles included carrion from road kills, big game winter ranges, and livestock operations; newly-emerging ground squirrels during early spring, and gut piles left by hunters during fall.

E. ROAD SURVEYS

A total of 1142 raptors was sighted during 27546 km (17120 miles) driven. Three species (northern harrier, Swainson's hawk, and American kestrel) comprised over half the total sightings (Table 6). The number of American kestrels per distance driven is an underestimation because kestrel sightings were not recorded during the first few months of the study. A total of 41.5 birds per 1000 km driven, and 18 species were recorded. This is less than half the number recorded by Woffinden and Murphy (1977) in the eastern Great Basin of Utah (100.2 birds/1000 km traveled), and Craig (1978) in southeastern Idaho (84.9 birds/1000 km traveled).

Table 6. Relative abundance of raptor species observed while driving 27546 km along roads in the Rocky Mountain Front shady area, northcentral Montana, December 1981 - August 1984.

SPECIES	NUMBER OBSERVED	NUMBER PER 1000 MILES DRIVEN	NUMBER PER 1000 KM DRIVEN	PERCENT ABUNDANCE
N. Harrier	259	15.1	9.4	22.7
American Kestrel	181	10.6	6.6	15.8
Swainson's Hawk	176	10.3	6.4	15.4
Red-Tailed Hawk	175	10.2	6.4	15.3
Golden Eagle	162	9.5	5.9	14.2
Prairie Falcon	72	4.2	2.6	6.3
Ferruginous Hawk	36	2.1	1.3	3.2
Rough-Legged Hawk	20	1.2	0.7	1.8
Bald Eagle	18	1.2	0.7	1.6
Great Horned Owl	12	0.7	0.4	1.1
Sharp-Shinned Hawk	9	0.5	0.3	0.8
Cooper's Hawk	8	0.5	0.3	0.7
N. Goshawk	5	0.3	0.2	0.4
Short-eared Owl	3	0.2	0.1	0.3
Merlin	2	0.1	0.1	0.2
Osprey	2	0.1	0.1	0.2
Gyr Falcon	1	0.1	0.04	0.1
Turkey Vulture	1	0.1	0.04	0.1
TOTAL	1142	66.7	41.5	100

VI. DISCUSSION

A. NESTING POPULATION DENSITY

The number of nesting pairs on the study area was estimated for each species for comparison with other studies (Table 7). The estimates are based upon pairs which were encountered during the study and are probably considerably below the actual number present for most of the species. The total population was estimated to be about 446 pairs or 9.5 pairs per 100 sq km. A population estimate of the common raven (Corvus corax) was not attempted although they are ecologically classified as raptors

and are included in the population estimates of most of the other studies cited below. The nesting density of raptors on the East Front was slightly higher than average in comparison to other areas in several western states, but far below the exceptionally high densities found on the Birds of Prey Natural Area and the adjacent Grandview area of southern Idaho (Table 8).

Table 7. Estimated breeding densities for 18 species of raptors in the 4700 sq km Rocky Mountain Front study area, northcentral Montana, 1982 - 1984 (based upon active nests and sightings of territorial pairs).

SPECIES	ESTIMATED NO. OF PAIRS	NO. PAIRS PER 100 SQ KM	NO. SQ KM PER PAIR	PERCENT OF TOTAL PAIRS
Northern Harrier	85	1.8	55	19.1
American Kestrel	73	1.6	64	16.4
Red-tailed Hawk	57	1.2	82	12.8
Prairie Falcon	52	1.1	90	11.7
Great Horned Owl	46	1.0	102	10.3
Swainson's Hawk	45	1.0	104	10.1
Golden Eagle	37	.8	127	8.3
Saw-whet Owl	15	.3	313	3.4
Ferruginous Hawk	10	.2	470	2.2
N. Goshawk	10	.2	470	2.2
Great Gray Owl	5	.1	940	1.1
Merlin	4	.1	1175	0.9
Short-eared Owl	2	.04	2350	0.4
W. Screech-owl	1	---	---	0.2
E. Screech-Owl	1	---	---	0.2
Pygmy Owl	1	---	---	0.2
Cooper's Hawk	1	---	---	0.2
Sharp-shinned Hawk	1	---	---	0.2
TOTAL	446	9.5	10.5	99.9

Table 8. Comparison of the nesting density of raptors in the Rocky Mountain Front study area, northcentral Montana, with areas in other western states.

LOCATION	STUDY AREA SIZE KM ²	NO. PAIRS	NO. PAIRS PER 100 km ²
Rocky Mountain Front, Montana	4700	446	9.5
BPNA, Idaho (Howard et al. 1976)	135	294	217.8
Grandview, Idaho (Howard et al. 1976)	117	163	139.3
Southern Idaho (Howard et al. 1976)	12437	464	3.7
Hanford, Washington (Olendorff 1973)	1036	44	4.2
Pawnee, Colorado (Olendorff 1975)	2590	159	6.1
Cedar Valley, Utah (Smith and Murphy 1973)	207	35	16.9
Moose, Wyoming (Craighead and Mindell 1981)	31.1	24.7	79.3
Medicine Bow, Wyoming (Oakleaf, 1978)	3626	111	3.1
TOTAL FOR ALL AREAS	24879.1	1740.7	7.0

Newton (1979) stated that the distribution and density of raptors are dependent upon the distribution of nest sites and food. In most cases, raptor populations are limited by the number of suitable nest sites available (mainly cliffs or trees). In the study area, the Sawtooth Range in the western half and the riparian areas and steep, eroded grassland ridges in the eastern half, provided most of the nesting habitat. Golden eagles and prairie falcons nesting in the Sawtooth Range were suspected to travel out onto the plains to hunt. Radio telemetry studies would be necessary to delineate foraging areas.

B. IMPACTS OF MAN'S ACTIVITIES

The primary human activities on the study area were livestock grazing, farming, logging, recreation, oil and gas exploration, and housing developments. Most of these activities were dispersed or too minor in extent to be detrimental to the raptor population. The most serious threat appeared to be the continuing conversion of native rangeland to dryland farming. During 1982, hundreds of acres of grasslands adjacent to a ferruginous hawk nesting area were plowed. Loss of habitat to dryland farming is one of the major threats to this species (Snow 1974a). Housing developments may become a problem in the future. Present zoning laws do not take into account wildlife habitat. The Forest Plan for the Lewis and Clark National Forest (U.S.D.A. Forest Service 1982) called for increases in grazing and timber harvest levels. The levels of recreation and oil and gas exploration were also expected to increase. Increased road construction would be associated with all of these activities.

Man's activities usually have the potential to impact raptors in one of the following ways: 1) direct mortality of individual birds (shooting, poisoning, electrocutions, etc.), 2) disturbance or pesticide contamination which results in lower productivity and recruitment, 3) elimination of nesting habitat, and 4) reduction of the prey base through poisoning or habitat destruction. Many authors have discussed the potential impacts of various types of disturbances and proposed general guidelines to protect raptors, but few have attempted to actually measure cause-effect relationships or the degree of protection needed (Suter and Jones 1981). Raptors are difficult to study for disturbance impacts because they are very mobile, have large home-ranges, relatively low population densities, and reproductive rates which often fluctuate widely from year to year due to poorly understood factors (Ellis 1981, Newton 1979, Brown 1970).

1. Direct Mortality

Direct man-caused mortality did not appear to be a major problem on the Rocky Mountain Front. Electrocutions on power lines (golden eagles and great horned owls) and collisions with vehicles (short-eared owls) were the only types of man-caused mortality observed. These mortality factors did not appear to be limiting raptor populations on the Rocky Mountain Front.

2. Loss of productivity

a. Pesticides

Fledging success from successful nests was average, indicating no apparent problem from pesticide contamination. Ellis (1979) and Leedy (1972) found the levels of contamination in golden eagles and prairie falcons to be under the threshold necessary to cause a significant reduction in productivity.

b. Disturbance

Loss of productivity due to disturbance of nesting pairs was difficult to assess because the causes for most nest failures were unknown. The sample size of nests was too small for comparison of productivity of nests near human activities (such as roads and dwellings) with those far from human activities. Most oil and gas exploration during the study was conducted after most raptors had fledged. Abandonment of one prairie falcon aerie in 1981 was believed to have been caused by seismic exploration activities (L. Young, pers. comm.). A goshawk nest located along a trail on a dude ranch was regularly disturbed by people on foot and horseback in 1983. The fledging success of one young was below the normal for goshawks, possibly due to disturbance. A ranch hand reported climbing up to a ferruginous hawk nest in 1983 and observing four eggs after the adult flushed. The nest fledged three young, and one unhatched egg remained intact in the nest after the young had fledged. This is in contrast to reports by many investigators of the extreme sensitivity of ferruginous hawks during incubation (Snow 1974a, Thurow et al. 1980).

One golden eagle nest containing two downy young (3-4 weeks old) was observed while a surface charge seismic line was conducted past the nest. The nest was located 76 m high on a 122 m cliff overlooking the plains. The line was initiated 5 km from the nest and ran directly toward the nest in full view of it. The adult golden eagle flushed from the nest each time a charge was set off when the line approached to within 1.6 km of the nest. The adult often remained off the nest for extended periods of time, sometimes flying back and forth in front of the cliff, and sometimes flying out of sight toward the south. The adult eagles did not approach the nest once the blasting approached to within 0.8 km. Blasting progressed to a point directly below the nest, then resumed several hundred meters down from the top of the cliff on the backslope of the hogback, out of sight of the nest. Both adults appeared back at the nest shortly after the blasting started on the other side of the hogback, and they no longer flushed when a charge was set off (the sound was muffled significantly by the hogback). The weather was mild (16-21°C with a high overcast) during the incident, reducing any danger to the young of exposure to extreme heat or cold. Ellis (1973) reported that nestling golden eagles suffered temporary weight

loss when the adults were kept away from the nest by the presence of observers. It is likely that death of the eggs or young would have occurred if the nest had been in the incubation or very early nestling stages.

Impacts of the study

Observer activities during the study may have had an impact on productivity, although every effort was made to minimize disturbance during data collection. Thurow et al. (1980) reported a significantly lower fledging rate for ferruginous hawk nests which were disturbed experimentally (approached until the adults left the nest) than nests which were not disturbed. During this study, the reactions of nesting raptors to observer approach varied with the raptor species, stage of the nesting season, and method of approach (helicopter, supercub or ground). Reactions of raptors were not quantified due to small sample sizes of observations.

Ground Surveys

Most raptor species were more alarmed by ground approaches (especially on foot) than by aircraft. This is similar to the findings of White and Sherrod (1973). Prairie falcons showed the least response to ground approaches mainly due to the great height above the ground of most aeries. Prairie falcons showed greater alarm when observer approaches were made from the tops of the cliffs, than from below. Swainson's hawks usually allowed the observer to approach more closely during incubation than while young were in the nest. The few incubating birds which were flushed flew away, while birds with nestlings vigorously defended the nest by stooping and screaming.

Fixed Wing Aircraft Surveys

Close approaches to nests with a supercub never caused golden eagles or buteos (red-tailed hawk, Swainson's hawk, ferruginous hawk) to flush from the nest. Incubating or brooding adults maintained brooding posture, and adults with young usually covered the young by spreading their wings over them. Prairie falcons occasionally flushed from the cliff and circled around near the airplane.

Helicopter Surveys

Close approaches by helicopter (to within 15m) rarely caused buteos to flush. Golden eagles never moved from brooding posture or flushed from the nest in spite of being buffeted by strong wind currents from the rotor blades. Prairie falcons often flushed ahead of the helicopter and circled in alarm. They were more easily flushed from the cliff with the helicopter, than with the supercub. Most prairie falcon aeries were in deep crevices or potholes, so behavior of brooding adults or nestlings was rarely observed. One female was observed to flush from an aerie with four eggs (the only aerie which could be looked into

from a helicopter), and another sat in the entrance of the pothole aerie and watched the helicopter go by. The response of prairie falcon nestlings to the helicopter was to flee into the back of the aerie, while golden eagle nestlings always remained stationary.

Active raptor nests were exposed to close aircraft approaches a maximum of three times (usually twice) during the nesting season. No nest abandonment due to aircraft approaches was suspected. Raptors probably have a threshold of tolerance to disturbance which, when exceeded, will result in nest abandonment or significantly lower productivity.

Some raptors may become conditioned to disturbance, successfully fledging young in spite of high levels of stimuli (Ellis 1981). Others may become sensitized to disturbance, flushing at greater distances with each additional approach (Thurrow et al. 1980).

3. Elimination of Nesting Habitat

Loss of nesting habitat will cause a decline in raptor populations if nesting habitat is limiting (Newton 1979). Declines associated with habitat loss can only be documented with long-term population studies. Craighead and Mindell (1981) attributed a 30 percent decrease in 28 years in the raptor population near Moose, Wyoming to a combination of habitat loss and increasing human disturbance. Habitat loss contributed to lower merlin populations near Kindersley, Saskatchewan (Hodson 1976).

Cliffs, conifer forests, and riparian zones were the most commonly used habitats for nesting by most raptor species on the Rocky Mountain Front, yet collectively they covered only fifteen percent of the study area. Ninety-eight pairs of raptors were found to use cliffs for nesting (golden eagle - 35, prairie falcon - 52, red-tailed hawk - 4, ferruginous hawk - 4, great horned owl - 2, and American kestrel - 1), resulting in a total density of 31 pairs per 100 km of cliff or 3.2 km per pair. Clearly, development causing loss of these habitats would have a much greater impact than development causing the loss of an equal amount of grassland or conifer savannah habitat. Riparian habitat on the Front has already suffered loss due to severe floods in 1964 and 1975, construction of two major water-storage reservoirs, and private home construction. Timber harvest could decrease conifer forest habitat suitable for goshawks if a greater than sustained yield is harvested, or a short rotation period is employed (which would decrease the amount of old-growth forest). Cliff habitat by itself is nearly immune to destruction, but adjacent disturbance could render them unsuitable for raptor nesting. Developments close to cliffs were responsible for the loss of several peregrine falcon nest sites in Utah (Porter and White 1973). Some nesting habitat has increased as a result of human activities. Shelterbelts were utilized for nesting by Swainson's hawks and great horned owls. Establishment and maintenance of additional shelterbelts could increase nesting habitat for these two species and possibly the red-tailed hawk.

4. Reduction of Prey Base

Reduction of the prey base through poisoning or habitat alteration such as grazing could cause a decline in a raptor population if the food supply is the limiting factor or the population (Newton 1979). Conversion of large areas of native grasslands to dryland crops or monotypic grasses is believed to have caused declines of ferruginous hawks by decreasing populations of jackrabbits (Snow 1974a, Howard and Wolfe 1976). Conversion of grassland to croplands is one of the major habitat changes presently occurring on the study area. The impact on prey species is impossible to determine without conducting extensive prey-base studies.

5. Cumulative Impacts

Combinations of impacts can interact to exert a greater cumulative impact on raptor populations than the sum of the impacts alone. Ferruginous hawks under stress from a decline of the prey base were less tolerant of disturbance, flushing at greater distances and abandoning their nests more readily than hawks with a good food supply (Thurrow et al. 1980). The highly interspersed public, state, and private lands on the Rocky Mountain Front could increase the likelihood of several different types of developments taking place without regard for cumulative impacts.

VII. Management Recommendations

The goals of raptor management on the Rocky Mountain Front should be to maintain viable and diverse raptor populations and to maintain suitable habitat for endangered species. Portions of the study area were prioritized according to the status of the species involved. Protective stipulations also vary in restrictiveness according to the needs and status of the species.

General Raptor Guidelines:

1. Avoid seasonally important areas for raptors, including nesting, foraging, and wintering areas.
2. Prohibit the use of chlorinated hydrocarbon pesticides to prevent lowered reproductive rates due to eggshell thinning.
3. Prohibit exposed bait poisoning and trapping of predators.
4. Raptor nest locations should only be revealed to authorized personnel.
5. Plan power and telephone lines to reduce the possibility of raptor mortality from collisions. Bury power lines whenever possible. Replace individual poles in existing lines shown to cause raptor mortality with poles designed to prevent electrocution (Olendorff, et al. 1981). Install markers on wires spanning rivers, canyons, and other areas heavily used by raptors to reduce collisions with the wires.

Type 1. Areas occupied by nesting bald eagles or peregrine falcons:

No endangered raptor species are known to nest on the Rocky Mountain Front. Should nesting peregrine falcons or bald eagles be discovered, a site-specific nest management plan should be developed. Three zones should be defined around the nest: 1) Nesting Zone (400 m), 2) Primary Use Area (800 m), and 3) Home Range (4 km). Sizes of the zones are approximate and should be modified in the nest management plan to include the areas actually used by the pair. These guidelines were developed by the Greater Yellowstone Ecosystem Bald Eagle Working Team (1983). Guidelines developed by the Montana bald eagle and peregrine falcon working groups should be used when they are completed.

A. Nesting season (February 1 - July 31)

1. Prohibit human activities within 800 m of occupied nests, with the exception of necessary research by qualified biologists. Previously existing low level activities such as hiking trails can be continued in the Primary Use Area (400-800m) only if they do not adversely affect the birds.
2. Prohibit helicopter or jet overflights within the Nesting Zone (400 m) and restrict overflights to above 600 m in the Primary Use Area (400 - 800 m).
3. Prohibit surface-charge seismic exploration within 1600 m of the nest.

B. Non-nesting season (August 1 - January 31)

1. Human activities that do not degrade nesting and foraging habitat are permitted within 800 m of the nest. These include dispersed recreation and properly conducted seismic exploration.
2. Housing developments, exploratory drilling, heavy construction, additional campgrounds and boat landings, and other activities which degrade habitat quality or increase human activity levels are prohibited within 800 m of bald eagle and peregrine falcon nests.
3. Prohibit all timber harvest within 800 m and in important foraging habitat within 4 km of bald eagle nests, including firewood cutting, snag removal, and thinning.
4. Timber harvest may be permitted within 800 m of peregrine falcon nests during the non-nesting season if a site evaluation determines no detrimental impacts on the peregrines. Associated roads should be closed and reclaimed upon completion of the harvest.

5. Habitat alterations within 400 m of bald eagle and peregrine falcon nests should be restricted to projects specifically designed to maintain or enhance bald eagle or peregrine falcon habitat.
6. Power and telephone lines should not be constructed within 800 m of bald eagle or peregrine falcon nests. Existing structures should be modified if they pose a hazard to raptors.

Type 2. Potential nesting habitat for bald eagles and peregrine falcons:

Management goals are to protect the habitat from deterioration to the point where it would no longer be suitable nesting habitat.

1. Prohibit disturbing human activities within 800 m of historic nest sites during the nest site selection period (February 1 - April 30).
2. Prohibit human activities that cause habitat loss or an increase in human activity within potential nesting habitat. This includes additional campgrounds and boat landings, housing developments, oil and gas fields, and additional roads.
3. Prohibit activities which have the potential to decrease or eliminate existing populations of prey species for bald eagles and peregrine falcons, especially fish, waterfowl, and shorebirds. Encourage activities which have the potential to enhance prey species populations.
4. Employ forest management practices which maintain or increase old-growth forests in potential bald eagle nesting habitat.

Type 3. Areas occupied by nesting special interest species (Flath 1981), including the golden eagle, northern goshawk, ferruginous hawk, prairie falcon, and merlin.

Management goals are to protect occupied nest sites from disturbance and maintain habitat quality.

1. Prohibit surface-charge seismic exploration or other use of explosives within 1.6 km (one mile) of occupied nesting habitat during the nesting season (dates listed in Table 9).
2. Prohibit other human activities that have the potential to disrupt nesting activities within the dates and buffer zones listed in Table 9. Suggested buffer zones are based upon recommendations by Becker (1982), Suter and Jones (1981), Becker and Ball (1981a, 1981b), Thurow et

al. (1980), Call (1979), and Allen (1979). the buffer zones may be adjusted to allow for topographic features which offer screening from disturbance, or for less tolerant individual raptors, but buffer zones should not be less than 300 m in any case. Types of activities which should be restricted include heavy construction, timber harvest, exploratory drilling, porta-drill seismic exploration, and helicopter flight corridors.

Table 9. Recommended buffer zones and average dates of nesting seasons for five species of raptors on the Rocky Mountain Front, northcentral Montana.

Species	Approximate Dates Of Nesting Season	Recommended Buffer Zone (Meters)*
Golden Eagle	Feb. 1 - July 30	600 m
Northern Goshawk	April 15 - August 15	400 m
Ferruginous Hawk	April 1 - July 30	600 m
Merlin	April 15 - August 15	500 m
Prairie Falcon	Feb. 15 - July 30	500 m

*Exception - buffer zone for surface charge seismic lines is 1600 m (1 mile) for all species (see guideline number 1 above).

3. Activity patterns that have been established for at least three years can continue within buffer zones at current levels. These include established roads, pack trails, campgrounds, and dwellings.

4. Timber harvest, including firewood cutting, snag removal, and thinning should be prohibited within 300 m of goshawk nests year long.

Type 4. Potential nesting habitat for the northern goshawk, prairie falcon, golden eagle, merlin, ferruginous hawk, Swainson's hawk, red-tailed hawk, northern harrier, and great horned owl.

These include riparian habitat, conifer forest, and cliffs which are not classified under Type 3. Management goals are to protect these habitats from deterioration, since they cover only 12 percent of the study area, yet provide essential nesting habitat for nearly all raptor species on the Rocky Mountain Front.

1. Employ timber harvest levels and rotation periods which maintain and regenerate current levels of mature to overmature stands of conifers.

2. Avoid placing roads, drill pads, campgrounds, and other habitat disrupting developments in potential nesting habitat.

Type 5. Areas not used for nesting (includes foraging and wintering areas).

Management goals are to maintain habitat quality to support prey populations which are adequate to maintain current raptor populations.

1. Prohibit disturbing human activities such as heavy construction, seismic exploration, exploratory drilling, and timber harvest in bald eagle winter concentration areas from December 1 - April 15.
2. Prohibit disturbing human activities in important foraging areas.
3. Reclamation of areas disturbed during development should be designed to enhance prey populations.

Protective stipulations are only good if they are enforced. Stipulations on public lands should not be violated, except in cases of extreme need. If buffer zones or time restrictions are violated, the impacts to raptors should be monitored to provide information for formulating more efficient protective stipulations for that activity and species. Stipulations should be evaluated and modified as needed. Raptor populations should be monitored over the long-term, to detect any changes resulting from man's activities.

Enhancement Activities For Raptors

The following are suggestions for programs that would have the potential to enhance raptor populations on the Rocky Mountain Front.

1. Implement land management plans that perpetually protect and provide habitat important to raptors and their prey species.
2. Install artificial nesting platforms in areas of extensive grasslands to provide nesting structures for golden eagles, red-tailed hawks, and ferruginous hawks, in areas where it can be demonstrated that populations of these species will benefit without impacting other special interest species such as black-footed ferrets and Swainson's hawks (through predation or competition).
3. Encourage planting and maintenance of shelterbelts in agricultural areas. Shelterbelts have the potential to provide nesting areas for Swainson's hawks, red-tailed hawks, merlins, great horned owls, and long-eared owls.

4. Install dikes to retain water on areas that are presently exposed as mud flats on the upper ends of reservoirs which are severely dewatered during the summer (Eureka, Bynum, and Nilan Reservoirs). This would greatly enhance waterfowl and shorebird production which would in turn provide a better prey base for prairie falcons and peregrine falcons. This would also reduce blowing dust from these areas. Islands should be constructed in the dike ponds to provide nesting areas for waterfowl.
5. Install nest boxes to provide nesting areas for American kestrels, saw-whet owls, northern pygmy-owls, and screech-owls in places where it can be demonstrated that these species will benefit from additional nest sites.
6. Encourage reseeding of highly erodable crop lands to native vegetation to improve the small mammal prey base.
7. Revegetate clearcuts and disturbed areas with a diversity of native plant species rather than a monoculture of imported or native plants.

VIII. SUMMARY

1. A raptor survey was conducted from December 1981 through October 1983 in a 4700 sq km study area on the Rocky Mountain Front, northcentral Montana.
2. The purpose of the study was to gather baseline information on raptor distribution, abundance, habitat use and productivity, to be used to monitor changes brought about by man's activities.
3. Habitat types on the study area were lumped into broad categories (grassland, riparian, conifer forest, conifer savannah, agricultural, water, and cliff), and delineated on U.S.G.S. topographic maps.
4. Nesting surveys were conducted using helicopter, fixed-wing aircraft, and ground surveys. Road surveys, great horned owl hooting surveys and bald eagle winter surveys were also conducted.
5. Grassland and conifer savannah were the predominant habitats, covering a total of 72 percent of the study area. Conifer forest, riparian, and cliff habitats combined only covered 15 percent of the study area.
6. The most common diurnal species were the golden eagle, northern harrier, prairie falcon, Swainson's hawk, red-tailed hawk, and American kestrel.
7. A total of 122 golden eagle nests was found, most of which were alternate nests for about 37 nesting pairs. The majority of nests were on cliffs with east or northeast exposures. Fledging success for golden eagles averaged 1.4 young per successful nest in 1982, 1.25 in 1983, and 1.25 in 1984.
8. No nesting bald eagles were found during the study, although two historic nests, last active in the 1950's, were located in the study area.
9. At least 85 nesting pairs of northern harriers were observed in the study area. One nest was located in a hayfield. Mesic grass-shrub coulees were probably also used for nesting.
10. Nesting goshawks were present in conifer forest habitat in the mountainous portion of the study area, and nesting was confirmed three times during the study (fledged young in 1982 and 1984, one active nest in 1983).
11. Twenty red-tailed hawk nests were found; 16 were in cottonwoods and four were on cliffs. The number of fledged young per successful nest was 1.75 in 1982, 1.86 in 1983, and 2.5 in 1984.

12. Thirty-two Swainson's hawk nests (including two alternates) were found, all in deciduous trees or shrubs. The number of young fledged per successful nest was 1.67 in 1982, 2.11 in 1983 and 2.0 in 1984.
13. Thirty-three ferruginous hawk nests were found, most of which were alternates for about ten nesting pairs. Seven nests (21 percent) were located on small sandstone cliffs and the remainder were located on the ground. The number of young fledged per successful nest was 3.0 in both 1982 and 1983, although the proportion of nesting pairs which fledged young was small.
14. Nesting merlins were present in conifer savannah and riparian habitats. One of three nests located by previous studies was confirmed to be active during this study, and one additional nest was located. Three of the nests were in limber pine and one was in a cottonwood.
15. Fifty-seven pairs of prairie falcons were found in or adjacent to the study area. The number of young fledged per successful nest was 3.2 in 1982, 3.8 in 1983, and 4.5 in 1984.
16. No nesting peregrine falcons were found during the study, although many of the cliffs in the study area were suitable nesting habitat. Occasional migrant peregrines have been reported by other observers.
17. The great horned owl and saw-whet owl were the two most common nocturnal raptor species.
18. Ten great horned owl nests were found, in riparian habitat, cliffs, and abandoned buildings. The number of young fledged per successful nest was 2.0 in both 1982 and 1983.
19. Small numbers of bald eagles were present as migrants and winter residents.
20. A total of 41.5 raptors per 1000 km driven was recorded during the study.
21. The total nesting population density was estimated to be about 9.5 pairs per 100 sq km.
22. Current human activities on the study area that could impact raptors are sodbusting, timber harvest, oil and gas exploration, livestock grazing, recreation, and housing developments.
23. Possible impacts on raptors as a result of human activities included direct mortality, loss of productivity, loss of nesting habitat, and a decrease in prey populations.
24. Raptors were more alarmed by observer approaches on the ground, than by helicopter or fixed-wing aircraft. No nest-failures were known to have been caused by observer activities.

25. Management goals are to maintain a healthy and diverse raptor population and to maintain suitable nesting habitat for bald eagles and peregrine falcons.
26. Suggested management recommendations included buffer zones around active nests, restriction of activities to outside the nesting season, and restriction of activities that would result in long-term deterioration of conifer forest, riparian, and cliff habitats.

LITERATURE CITED

- Allen, G. T. 1979. An assessment of potential conflicts between nesting raptors and human activities in the Long Pines area of southeastern Montana. MS thesis, Washington State U., Pullman. 109pp.
- Andryk, T. A. 1983. Ecology of bighorn sheep in relation to oil and gas development along the east slope of the Rocky Mountains, Northcentral Montana. MS Thesis, Montana State Univ., Bozeman. 100pp.
- Anthony, R.G., R.L. Knight, G.T. Allen, B.R. McClelland, and John I. Hodges. 1982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. 47th North American Wildlife Conf.: 332-342.
- Aune, K. and T. Stivers. 1983. Rocky Mountain Front grizzly bear monitoring and investigation. Unpubl. Annual Prog. Rep., Mont. Dept. Fish, Wildl. and Parks, Helena. 143pp.
- Baglien, J. W. 1975. Biology and habitat requirements of the nesting Golden Eagle in southwestern Montana. MS thesis, MSU, Bozeman, 53pp.
- Becker, D. M. 1982. A survey of raptors on national forest land in Carter County, Montana. Unpubl. Rep., U.S. Forest Service, Northern Region, Missoula. 61pp.
- _____ and I. J. Ball. 1981. a. Impacts of surface mining on North American merlins: recommendations for monitoring and mitigation. Unpubl. Rep. Mont. Coop. Wildl. Res. Unit, Missoula. 35pp.
- _____ and _____. 1981. b. Impacts of surfacing mining on prairie falcons: recommendations for monitoring and mitigation. Unpubl. Rep. Mont. Coop. Wildl. Res. Unit, Missoula. 39pp.
- Bent, A. C. 1938. Life histories of North American birds of prey. U. S. Natl. Mus. Bull. No. 170, pt. 2. Washington D. C.
- Bloom, P. H. 1980. The status of the Swainson's hawk in California, 1979. Unpubl. Rep., Calif. Fish and Game, nongame wildlife investigation.
- Boeker, E. L. 1970. Use of aircraft to determine golden eagle nesting activity. Southwest Nat. 15(1):136-137.
- Bond, R. M. 1946. The peregrine population of western North America. Condor 48(3): 101-116.
- Boyce, D. A. and C. M. White. 1979. A peregrine falcon nesting habitat survey on U. S. Forest Service lands in NW California - 1979. Wilderness Research Institute, Arcata, California, 59pp.

- Brown, L. H. 1970. Some factors affecting breeding in eagles. Ostrich supp. 8:157-167.
- Call, M. W. 1978. Nesting habitats and surveying techniques for common western raptors. U.S.D.I. BLM Denver Service Center. TN-316. 70pp.
- . 1979. Habitat management guides for birds of prey. U.S.D.I. BLM Tech. note T-N 338. 70pp.
- Craig, Timothy H. 1978. A car survey of raptors in southeastern Idaho 1974-1976. Raptor Res. 12(1/2): 40-45.
- Craighead, F. C., Jr. and D. P. Mindell. 1981. Nesting raptors in western Wyoming, 1947 and 1975. J. Wildl. Manage. 45(4):865-872.
- Craighead, J. J. and F. C. Craighead, Jr. 1956. Hawks, owls, and wildlife. Stackpole Co., Harrisburg, PA.
- Crenshaw, J. 1979. A faunistic survey of Pine Butte Swamp. Unpubl. Rep. Nature Conservancy, Helena, MT.
- DuBois, K. 1983. Rocky Mountain Front raptor survey - December 1981 - November 1982. Prog. Rep., Mt. Dept. Fish, Wildl. and Parks. 52pp.
- Ellis, D.H. 1973. Development of behavior in the golden eagle. Ph.D. Thesis, U. of Montana, Missoula. 416pp.
- . 1976. First breeding records of merlins in Montana. Condor 78(1): 112-114.
- . 1979. Development of behavior in the golden eagle. Wildl. Monogr. No. 70. 94pp.
- . 1981. Responses of raptorial birds to low level military jets and sonic booms. Inst. for Raptor Studies, Oracle, Ariz., 59pp.
- . 1982. The peregrine falcon in Arizona: habitat utilization and management recommendations. Institute for Raptor Research Report No. 1. Oracle, Ariz., 24pp.
- Enderson, J. H. 1964. A study of the prairie falcon in the central Rocky Mountain region. AUK 81(3): 332-352.
- . 1969. Population trends among peregrine falcons in the Rocky Mountain region. P. 73-79 in Peregrine Falcon Populations: their biology and decline, J. J. Hickey, ed. U. of Wis. Press, Madison.
- Erickson, G. L. 1972. The ecology of Rocky Mountain bighorn sheep in the Sun River area of Montana with special reference to summer food habits and range movements. MS Thesis, Mont. State Univ., Bozeman. 50pp.

- Flath, D. L. 1981. Vertebrate species of special concern. Mont. Dept. Fish, Wildl. and Parks, Wildlife Div. 74pp.
- . 1983. Distribution status, population recruitment and habitat use of bald eagles in Montana. Unpubl. Prog. Rep. Mont. Dept. Fish, Wildl. and Parks.
- Fox, G. A. 1964. Notes on the western race of the pigeon hawk. Blue Jay 12:140-147.
- Frisina, M.R. 1974. Ecology of bighorn sheep in the Sun River area of Montana during fall and spring. MS Thesis, Mont. St. Univ., Bozeman, 68pp.
- Fyfe, R. W. and R. R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Canadian Wildl. Serv. Occas. Paper No. 23, Ottawa, Ont.
- Gaines, R. L. and S. C. Kohn. 1982. Raptor use of hardwood draws in central North Dakota. Prairie Naturalist 14(2): 55-58.
- Gilmer, D. S., P. M. Konrad, and R. E. Stewart. 1983. Nesting ecology of red-tailed hawks and great horned owls in central North Dakota and their interaction with other large raptors. Prairie Nat. 15(3): 133-143.
- Gramlich, C. R. 1979. Raptor nesting inventory, East Front. Unpubl. Rep. BLM, Butte Dist., Butte, MT.
- Hayward, Gregory D. 1983. Goshawk east habitat selection in the northern region. U.S. Forest Serv., northern region, Missoula, Montana. 21pp.
- Hodson, K. A. 1976. The ecology of Richardson's merlins on the Canadian prairies. MS Thesis, Univ. of British Columbia, Vancouver. 83pp.
- Hoel, P. G. 1966. Elementary statistics, 2nd ed., John Wiley and Sons, Inc. New York, London, Sydney, 351pp.
- Howard, R. P. and M. L. Wolfe. 1976. Range Improvement Practices and ferruginous hawks. J. Range Manage. 29(1): 33-37.
- Howard, Richard P., Lanny O. Wilson and Frank B. Renn. 1976. Relative abundance of nesting raptors in southern Idaho. Raptor Research 10(4): 120-128.
- Huhtala, K. and S. Sulkava. 1981. Environmental influences on goshawk breeding in Finland. pp. 89-104 in Understand the goshawk. R. K. Kenward and I. M. Lindsay, eds. Proc. of symposium, International Assoc. for Falconry and Conservation of Birds of Prey. Oxford, UK.

- Ihsle, H. B. 1982. Population ecology of mule deer with emphasis on potential impacts of gas and oil development along the east slope of the Rocky Mountains, northcentral Montana. Unpubl. MS Thesis, Mont. St. Univ., Bozeman.
- Jasikoff, T. M. 1982. Habitat suitability index models: Ferruginous hawk. FWS/OBS-82/10.10.
- Jones, S. 1979. Habitat management series for unique or endangered species: The Acciptiers. USDI BLM Tech. Note No. TN-335.
- Joslin, G. 1983. Montana mountain goat investigations along the east front of the Rocky Mountains, Lewis and Clark National Forest. Unpubl. Annual Prog. Rep., Mont. Dept. Fish, Wildl. and Parks, Helena.
- Kasworm, W. F. 1981. Distribution and population characteristics of mule deer along the east front, northcentral Montana. Unpubl. MS Thesis, Mont. St. Univ., Bozeman.
- Knight, R. R. 1970. The Sun River elk herd. Wildl. Monogr. 23. 66pp.
- Leedy, R. R. 1972. The status of prairie falcons in western Montana: special emphasis on possible effects of chlorinated hydrocarbon insecticides. Unpubl. MS Thesis, Univ. of Mont., Missoula. 96pp.
- Lockhart, J. M. 1976. The effects of coal development on the ecology of birds of prey in southeastern Montana and northern Wyoming. Unpubl. Annual Prog. Rep., Wildl. Res. Work Unit, Denver Wildl. Res. Center, U.S. Fish and Wildl. Serv.
- , T. P. McEneaney, A. L. Harting, Jr. 1977. The effects of coal development on the ecology of Birds of Prey in southeastern Montana and northern Wyoming. Unpubl. Prog. Rep. U.S. Fish and Wildlife Serv., Denver Wildl. Res. Center
- Lokemoen, J. T. and H. F. Duebbert. 1976. Ferruginous hawk nesting ecology and raptor populations in northern South Dakota. Condor 78:464-470.
- McGahan, J. 1968. Ecology of the golden eagle. AUK 85(1):1-12.
- Menkens, G. E. 1982. Characterization of Golden Eagle nesting habitat in northeastern Wyoming. MS thesis, U. of Wyoming, Laramie, Wy., 59pp.
- Mosher, J. A. and C. M. White. 1976. Directional exposure of Golden Eagle nests. Can. Field-Nat. 90:356-359.

- Mudge, M. R. 1972a. Pre-quaternary rocks in the Sun River Canyon area, northwestern Montana. Geol. Surv. Prof. Paper 663-A.
- . 1972b. Structural geology of the Sun River Canyon and adjacent areas, northwestern Montana. Geol. Surv. Prof. Paper 663-B.
- Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service Gen. Tech. Rep. INT-66. 154pp.
- Nelson, M. W. 1969. The status of the peregrine falcon in the Northwest. P. 61-79 in Peregrine falcon populations: their biology and decline. J. J. Hickey, ed. U. of Wis. Press.
- Nero, Robert W. 1980. The great gray owl. Smithsonian Institution Press, Washington, D.C. 167pp.
- Newton, I. 1979. Population ecology of raptors. Buteo Books. Vermillion, S.D. 430 pp.
- Oakleaf, R. J. 1978. Medicine Bow raptor nesting survey. Prog. Rep., Wyoming Game and Fish Dept., 10pp + Appendix.
- Olendorff, R. R. 1973. Raptorial birds of the USAEC, Hanford Reservation, Southcentral Washington. Battle Pacific Northwest Labs. Rep. No. BNWL-1790 UC-11. 45pp.
- . 1975. Populations status of large raptors in northeastern Colorado - 1970-1972. Pages 185-205 in J.R. Murphy, L. M. White, and B. E. Harrell, ed., Population status of raptors. Raptor Res. Rep. No. 3.
- , A. Dean Miller, and Robert N. Lehman. 1981. Suggested practices for raptor protection on power lines - state of the art in 1981. Raptor Research Report No. 4, Raptor Research Foundation. 111pp.
- Olson, G. 1981. Effects of seismic exploration on summering elk in the Two Medicine-Badger Creek area, northcentral Montana. Unpubl. rep., Montana Dept. Fish, Wildl. and Parks. 24pp.
- Peterson, L. 1979. Ecology of great horned owls and red-tailed hawks in southeastern Wisconsin. Tech. Bull. No. 111, Dept. of Nat. Res., Madison, Wis. 63pp.
- Pfister, Robert D., Bernard L. Kovalchik, Stephen F. Arno and Richard C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service. Gen. Tech. Rep. INT-34, 174pp.
- Picton, H. D. 1960. Migration patterns of the Sun River elk herd, Montana. J. Wildl. Manage. 24(3): 279-290.
- Porter, R. D. and C. M. White. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. BYU Science Bull. Biological series, Vol. 18 No. 1. 74pp.

- Postupalski, S. 1974. Raptor reproductive success: some problems with methods, criteria and terminology. In Management of Raptors, F. N. Hamerstrom, B. E. Harrell and R. R. Olendorff, ed. Raptor Research Foundation.
- Ratcliffe, D. 1980. The peregrine falcon. Buteo Books, Vermillion, SD. 416pp.
- Reynolds, R. T., E. C. Meslow, H. M. Wight. 1982. Nesting habitat of coexisting Accipiter in Oregon. J. Wildl. Manage. 46(1):124-138.
- Schallenger, A. 1966. Food habits, range use and interspecific relationships of bighorn sheep in Sun River area, westcentral Montana. MS Thesis, Montana State Univ. Bozeman. 44pp.
- _____. 1975. Raptor reconnaissance survey of Rocky Mountain Front, Unpubl. Rep., Lewis and Clark Natl. For., Great Falls, Mont.
- Schmutz, J. K. S. M. Schmutz, and O. A. Boag. 1980. Coexistence of three species of hawks (Buteo spp.) in the prairie parkland ecotone. Can. J. Zool. 58:1075-1089.
- Seidensticker, J. C. 1970. Food of nesting red-tailed hawks in southcentral Montana. Murrelet 51(3): 38-40.
- Seidensticker, J. L. and H. V. Reynolds, III. 1971. Nesting performance and chlorinated hydrocarbon residues in the red-tailed hawk and great horned owl in southcentral Montana. Wilson Bull. 83(4):408-418.
- Shuster, William C. 1980. Northern Goshawk nest site requirements in the Colorado Rockies. W. Birds 11:89-96.
- Skaar, P. D. 1980. Montana bird distribution, 2nd ed. P.D. Skaar, 501 S. Third, Bozeman.
- Smith, D. G. and J. R. Murphy. 1982. Nest site selection in raptor communities of the eastern Great Basin Desert. Great Basin Nat. 42(3): 395-404.
- _____. and _____, 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young Univ. Sci. Bull., Biol. Ser. 18(3): 1-76.
- Snow, C. 1972. Habitat management series for endangered species: American peregrine falcon and Actic peregrine falcon. USDI BLM Tech. Note Rep. No. 1.

- _____. 1974. Habitat management series for unique or endangered species: ferruginous hawk. U.S.D.I. BLM Tech. Note No. TN-255. Denver Service Center, Denver, Col.
- _____. 1974. b Habitat management series for unique or endangered species: prairie falcon. U.S.D.I. BLM Tech. Note No. TN-240, Denver Service Center, Denver, Col.
- Suter, G. W. II and J. L. Jones. 1981. Criteria for golden eagle, ferruginous hawk and prairie falcon nest site protection. Raptor Research 15(1):12-18.
- Terres, J. K. 1980. The Audubon Society encyclopedia of North American birds, Alfred A. Knopf, New York.
- Thurrow, T. L., C. M. White, R. P. Howard, and J. F. Sullivan. 1980. Raptor ecology of Raft River Valley, Idaho. U. S. Dept. of Energy, Idaho Operations Office, Idaho Nat. Eng. Lab. EGG-2054. 45pp.
- Trimble, S. A. 1975. Habitat management series for unique or endangered species: Merlin. BLM Tech. Note. Rep. No. 15 41 pp.
- U.S.D.A., Forest Service. 1982. Proposed Lewis and Clark National Forest Plan. Lewis and Clark Natl. For., Great Falls, Mont.
- U.S.D.I., Bureau of Land Management. 1979. Snake River birds of prey special research report. BLM. Boise Dist., Boise, Idaho.
- Wenzel, E. O. 1982. Raptor observations, notes and nest locations: Rocky Mountain East Front, 1979-81. Unpubl. Rep., BLM, Butte Distr. Butte, Mont.
- White, Clayton M. and S. K. Sherrod. 1973. Advantages and disadvantages in the use of rotary-winged aircraft in raptor surveys. Raptor Research 7:97-104.
- Woffinden, Neil D. and Joseph R. Murphy. 1977. A roadside raptor census in the Eastern Great Basin - 1973-1974. Raptor Res. 11(3): 62-66.
- Woodgerd, W. R. 1952. Food habits of the golden eagle. J. Wildl. Manage. 16:457-459.
- Youmans, Cliff, J. Swenson and S. Knapp. 1981. Preliminary results of owl censuses in riparian and upland habitats in southeastern Montana. pp. 67-74 in Proc. Mont. Chapter the Wildlife Soc., J. H. Ormistor, ed. Great Falls, Mt.

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Appendix A. Climatological data from three reporting stations on the Rocky Mountain Front, northcentral Montana (C = Choteau Airport, G = Gibson Dam, B = Blackleaf).

Temperature - Degrees F							Precipitation-Inches		
Mo/Yr	Reporting Station	Max.	Min.	Ave. Max.	Ave. Min.	Ave.	Deviation From Normal	Total	Deviation From Normal
11/81	C	73	11	51.8	30.6	41.2	7.4	Tr	-0.43
	G	69	3	48.3	27.8	38.1	4.9	0.20	-1.00
	B								
12/81	C	55	-17	35.4	17.0	26.2	-0.2	0.18	-0.15
	G	52	-14	33.3	16.8	25.1	-1.8	0.94	0.01
	B			33.5	11.6	22.6		0.28	
1/82	C	47	-27	21.2	-2.3	9.5	-11.6	0.34	0.02
	G	47	-28	28.2	4.4	16.3	-5.8	1.39	0.42
	B			16.2	-6.4	4.9		1.0	
2/82	C	58	-15	33.0	11.2	22.1	-4.6	.41	.06
	G	50	-25	33.9	12.1	23.0	-3.7	1.91	1.17
	B	57	-17	35.0	6.9	21.0		0.65	
3/82	C	53	3	38.9	19.9	29.4	-1.1	0.30	-0.14
	G	49	4	40.0	20.4	30.2	1.1	1.61	0.58
	B			38.0	15.4	26.7		0.92	
4/82	C	75	8	51.5	27.6	39.6	-2.7	0.22	-0.62
	G	68	-1	46.9	24.4	35.7	-3.6	0.92	-0.61
	B			49.9	23.1	36.5		0.35	
5/82	C	83	30	63.4	37.5	50.5	-1.1	1.48	-0.74
	G	76	22	59.4	32.8	46.1	-1.4	1.45	-1.76
	B			61.8	31.1	46.5		3.19	
6/82	C	86	35	73.2	48.0	60.6	1.9	2.55	-0.71
	G	81	33	68.9	42.8	55.9	1.9	2.33	-1.83
	B			70.2	44.6	57.4		3.51	
7/82	C	92	45	79.5	52.9	66.2	-0.1	0.80	-0.60
	G	86	35	75.2	47.3	61.3	-0.5	0.86	-0.51
	B			77.2	48.5	62.9		0.69	
8/82	C	91	37	83.2	51.2	67.2	2.8	0.32	-0.76
	G	86	37	77.7	47.0	62.4	1.7	0.86	-0.57
	B			81.8	46.7	64.3		0.89	
9/82	C	89	30	68.3	43.6	56.0	1.0	1.45	0.46
	G	86	28	65.1	39.1	52.1	-0.3	2.63	1.09
	B	88	23	68.6	36.9	52.8		1.84	
10/82	C	75	17	59.2	36.1	47.7	0.7	0.05	-0.38
	G	74	20	56.2	33.2	44.7	-0.1	0.21	-0.96
	B	76	13	60.1	29.1	44.6			
11/82	C	52	-5	39.8	20.8	30.3	-3.5	0.18	-0.25
	G	52	-2	39.4	19.6	29.5	-3.7	0.55	-0.65
	B	52	-14	39.2	12.9	26.1		0.37	
12/82	C	55	-2	36.8	19.7	28.3	1.9	0.11	-0.22
	G	57	-4	35.6	19.9	27.8	-0.9	0.55	-0.38
	B	52	-5	36.4	13.9	25.2		0.26	
1/83	C	62	2	44.8	22.6	33.7	13.8	.05	-.29
	G	57	5	42.4	23.5	33.0	11.8	.49	-.68
	B								
2/83	C	61	3	46.5	25.7	36.1	8.7	.06	-.24
	G	63	2	44.5	25.2	34.9	7.3	.09	-.68
	B	65	0	46.8	21.8	34.3		.18	-.45

Appendix A. (continued)

Temperature - Degrees F

Precipitation-Inches

Mo/Yr	Reporting Station	Max.	Min.	Ave. Max.	Ave. Min.	Ave.	Deviation From Normal	Total	Deviation From Normal
3/83	C	66	5	46.5	25.6	36.1	4.5	.47	.11
	G	60	2	43.9	23.8	33.9	4.1	2.03	1.05
	B	68	2	44.5	22.5	33.5		.98	.32
4/83	C	71	16	55.0	29.3	42.2	.3	.11	-.82
	G	64	11	50.2	26.6	38.4	-.5	.61	-1.12
	B	71	7	52.4	24.8	38.6		0.19	-1.21
5/83	C	83	24	65.1	38.9	52.0	-.2	.65	-1.51
	G	79	21	60.9	34.0	47.5	-.2	1.96	-1.15
	B								
6/83	C	84	38	72.5	47.4	60.0	0	1.16	-1.47
	G	81	33	68.6	43.3	56.0	1.0	3.76	.4
	B	82	28	69.6	42.3	56.0		1.63	-1.24
7/83	C	90	43	79.2	51.7	65.5	-1.3	1.84	.45
	G	85	38	74.8	46.9	60.9	-1.1	1.87	.47
	B								
8/83	C	102	43	87.1	57.1	72.1	7.0	0.50	-.75
	G	96	41	81.9	49.5	65.7	5.0	1.66	0.08
	B	101	39	86.0	53.1	69.6		.35	-1.16
9/83	C	90	26	67.9	40.4	54.2	-1.8	0.99	0.15
	G	83	17	63.6	38.2	50.9	-1.9	1.17	-0.12
	B	88	19	66.9	36.8	51.9		1.41	0.33
10/83	C	77	24	62.0	37.7	49.9	2.4	0.22	-0.22
	G	72	25	58.5	35.3	46.9	2.0	0.07	-0.91
	B	76	18	61.8	29.4	45.6		0.02	-0.50
11/83	C	65	-2	44.1	26.8	35.5	1.8	0.29	-0.10
	G								
	B	68	-14	44.8	22.8	33.8		0.53	-0.04
12/83	C	47	-35	17.3	-2.5	7.4	-18.9	0.12	-0.21
	G	45	-39	20.3	-1.8	9.3	-17.2	0.41	-0.62
	B	47	-41	16.8	-10.3	3.3		0.64	-0.08
1/84	C	64	-11	40.9	21.6	31.3	11.4	0.17	-0.17
	G	61	-20	39.6	22.1	30.9	9.7	0.68	-0.49
	B	64	-20	43.1	15.8	29.5		0.67	-0.04
2/84	C	66	17	49.0	28.7	38.9	11.5	T	-0.30
	G	58	10	45.1	27.4	36.3	8.7	0.01	-0.76
	B	68	14	51.6	27.1	39.4		0.05	-0.58
3/84	C	58	9	47.5	24.5	36.0	4.4	0.04	-0.32
	G	53	9	43.3	24.0	33.7	3.9	0.80	-0.18
	B	61	9	44.3	22.2	33.3		0.22	-0.44
4/84	C	81	18	55.4	31.9	43.7	1.8	0.7	-0.23
	G	74	15	50.5	29.2	39.9	1.0	3.33	1.60
	B	80	11	56.8	25.3	41.1		2.39	0.99
5/84	C	88	29	65.2	39.7	52.5	0.3	0.59	-1.57
	G	83	28	60.2	37.4	48.8	1.1	1.08	-2.03
	B	86	24	63.4	35.1	49.3		0.83	-1.67

Appendix B. Approximate portions of the Rocky Mountain Front study area surveyed in previous raptor studies.

Appendix C. Habitat mapping categories used for the Rocky Mountain Front raptor study area, northcentral Montana.

Map Symbol	Category
F	<u>Conifer forest</u> - Plant communities dominated by coniferous trees with a canopy coverage of at least 40 percent, and average height of at least 9 meters. Several different habitat types are included in this category, including <u>Pseudotsuga menziesii/Arnica cordifolia</u> , <u>Pseudotsuga menziesii/Spiraea befulifolia</u> , and <u>Pinus contorta</u> seral types.
S	<u>Conifer savannah</u> - Plant communities dominated by coniferous trees with a canopy coverage of less than 40 percent and/or stand heights of less than 9 meters. <u>Pinus flexilis</u> types are the main communities in this category, but other forest types are included, especially logged, burned, or high elevation stands, and forested scree. Small areas of non-forested scree ridge tops are also included.
G	<u>Grassland</u> - Both mountain and prairie grassland/shrubland types are included. Predominant types include <u>Stipa comata/Bouteloua gracilis</u> , <u>Agropyron spicatum/Bouteloua gracilis</u> , <u>Agropyron spicatum/Agropyron smithii</u> , <u>Festuca scabrella/Agropyron spicatum</u> , <u>Potentilla fruticosa/Festuca idahoensis</u> , and <u>Artemisia tridentata/Festuca scabrella</u> (Meuggler).
R	<u>Riparian</u> - A variety of deciduous tree and shrub types are included. The primary tree types include <u>Populus trichocarpa</u> , <u>Populus angustifolia</u> , and <u>Populus tremuloides</u> . Shrub types include <u>Salix</u> spp., <u>Betula occidentalis</u> , <u>Prunus virginiana</u> , <u>Rosa</u> spp., and <u>Symphoricarpos</u> spp. Wet grass-sedge meadows and gravel areas in early plant successional stages on flood plains are also included. Riparian types are primarily found along rivers and streams, ephemeral streams, and mesic coulees surrounded by grasslands.
W	<u>Water</u> - Permanent bodies of water (reservoirs, lakes, and ponds) are included.
A	<u>Agricultural</u> - Any non-native type that is periodically plowed or cut is included. Major types include dryland and irrigated alfalfa or grass hay, summer fallow, wheat, barley, and oats. The majority of agricultural land in the study area is in wheat or summer fallow.
C	<u>Cliff</u> - Rock formations with vertical or nearly vertical slopes are included. The main types are limestone or dolomite in the Sawtooth Range and sandstone in the prairie areas.

Appendix D. Number of aerial survey hours conducted on the Rocky Mountain

Front, northcentral Montana, 1982, 1983, and 1984.

	1982		1983		1984	
	Supercub (hours)	Helicopter (hours)	Supercub (hours)	Helicopter (hours)	Supercub (hours)	Helicopter (hours)
Winter						
(Jan-Feb)	5.25	0	4.5	0	2	0
Spring						
(April-May)	4.8	3.75	9.5	12.0	0	4.5
Summer						
(June-July)	4.6	11.5	3.0	14.5	0	16.75
TOTALS	14.65	15.25	17.0	11.5	2	21.25

Appendix E. Areas covered during aerial surveys on the Rocky Mountain Front,
northcentral Montana, 1982 - 1984.

Appendix F. Habitat types on the Rocky Mountain Front raptor study area, northcentral Montana - Key Map.

Appendix F. Arsenic Peak

Appendix F. Augusta

Appendix F. Barr Creek

Appendix F. Bean Lake

Appendix F. Benchmark

Appendix F. Blackleaf

Appendix F. Blowout Mountain

Appendix F. Bowmans Corners

Appendix F. Bynum

Appendix F. Cadotte Creek

Appendix F. Caribou Peak

Appendix F. Castle Reef

Appendix F. Cave Mountain

Appendix F. Choteau

Appendix F. Double Falls

Appendix F. Dupuyer West

Appendix F. Ear Mountain

Appendix F. Fish Lake

Appendix F. Freezeout Lake

Appendix F. Gouchnour Ranch

Appendix F. Jakie Creek

Appendix F. Johnson Mountain

Appendix F. Krone Ranch

Appendix F. Lake Theboe

Appendix F. Mount Wright

Appendix F. Nilan Reservoir

Appendix F. Our Lake

Appendix F. Patricks Basin

Appendix F. Pendroy

Appendix F. Porphyry Reef

Appendix F. Pretty Prairie

Appendix F. Robere

Appendix F. Rogers Pass

Appendix F. Sawtooth Ridge

Appendix F. Scoffin Butte

Appendix F. Split Rock Lake

Appendix F. Steamboat Mountain

Appendix F. Swift Reservoir

Appendix F. Twin Lakes

Appendix F. Volcano Reef

Appendix F. Walling Reef

Appendix F. Wood Lake

Appendix G. Breeding status of the raptor species found on the Rocky Mountain Front, northcentral Montana.

Species	Breeding Confirmed	Breeding Suspected	Nonbreeding (migrant or winter resident only)
Turkey Vulture		X	
Golden Eagle	X		
Bald Eagle			X
Northern Harrier	X		
Sharp-shinned Hawk	X		
Cooper's Hawk	X		
Northern Goshawk	X		
Broad-winged Hawk			X
Red-tailed Hawk	X		
Swainson's Hawk	X		
Rough-legged Hawk			X
Ferruginous Hawk	X		
Osprey			X
American Kestrel	X		
Merlin	X		
Prairie Falcon	X		
Peregrine Falcon			X
Gyr Falcon			X
Short-eared Owl		X	
Long-eared Owl		X	
Great Horned Owl	X		
Barred Owl			X
Great Gray Owl		X	
Snowy Owl			X
Eastern Screech-Owl		X	
Western Screech-Owl		X	
Northern Pygmy Owl		X	
Northern Saw-whet Owl		X	
Burrowing Owl		X	

Appendix H. Nest-site characteristics of golden eagle nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1a	Cliff	91	46	50	1662	SE	Conifer Savannah
1b	Cliff	91	84	92	1677	SE	Conifer Savannah
1c	Cliff	91	53	58	1677	S	Conifer Savannah
1d	Cliff	76	46	60	1662	S	Conifer Savannah
1e	Cliff	91	15	17	1646	NE	Conifer Savannah
1f	Cliff	91	46	50	1677	NE	Conifer Savannah
1g	Cliff	76	69	90	1707	NE	Conifer Savannah
2a	Cliff	18	12	67	1756	S	Conifer Savannah
2b	Cliff	30	15	50	1756	SE	Conifer Savannah
2c	Cliff	12	9	75	1683	E	Conifer Savannah
3a	Cliff	244	130	53	2386	SE	Conifer Savannah
3b	Cliff	244	122	50	2378	E	Conifer Savannah
3c	Cliff	244	107	44	2363	E	Conifer Savannah
4a	Cliff	122	61	50	2012	E	Conifer Savannah
4b	Cliff	152	91	60	2012	E	Conifer Savannah
4c	Cliff	152	91	60	2012	E	Conifer Savannah
4d	Cliff	152	76	50	1982	SE	Conifer Savannah
4e	Cliff	137	69	50	1982	NE	Conifer Savannah
5	Cliff	76	38	50	2073	NE	Conifer Forest
6a	Cliff	30	15	50	2195	E	Conifer Forest
6b	Cliff	30	15	50	2195	E	Conifer Forest
7	Cliff	30	15	50	1707	SE	Conifer Savannah
8a	Cliff	24	12	50	2036	NE	Conifer Forest
8b	Cliff	46	23	50	2036	E	Conifer Forest
8c	Cliff	46	15	33	2027	NE	Conifer Forest
8d	Cliff	91	38	42	2027	NE	Conifer Forest
9	Cliff	46	23	50	1616	SE	Conifer Savannah
10	<u>Pseudotsuga</u> spp.	9	6	67	1299	N	Grassland
11a	Cliff	76	30	40	1677	E	Conifer Savannah
11b	Cliff	76	46	60	1692	E	Conifer Savannah
12	Cliff	61	30	50	1524	E	Conifer Savannah
13	Cliff	61	46	75	2012	NE	Conifer Forest
14	Cliff	46	23	50	1695	E	Conifer Forest
15	Cliff	24	6	25	2043	S	Conifer Savannah
16	Cliff	46	30	67	2012	S	Conifer Savannah
17a	Cliff	91	46	50	2207	E	Conifer Savannah
17b	Cliff	91	46	50	2207	E	Conifer Savannah
17c	Cliff	91	46	50	2207	E	Conifer Savannah
18	Cliff	122	61	50	2317	E	Conifer Savannah
19a	Cliff	76	30	40	2073	E	Conifer Forest
19b	Cliff	76	30	40	2073	E	Conifer Forest
19c	Cliff	76	30	40	2073	E	Conifer Forest
20a	Cliff	46	15	33	2055	E	Conifer Savannah
20b	Cliff	46	12	27	1860	N	Conifer Savannah
21	Cliff	91	61	67	1707	N	Conifer Savannah
22a	Cliff	183	122	67	2149	N	Conifer Savannah
22b	Cliff	183	137	75	2165	N	Conifer Savannah
22c	Cliff	244	152	62	2195	NW	Conifer Savannah
22d	Cliff	61	46	75	2165	NE	Conifer Savannah

Appendix H. (continued)

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
23a	Cliff	61	52	85	2073	SE	Conifer Savannah
23b	Cliff	46	38	83	2073	NE	Conifer Savannah
23c	Cliff	30	12	40	2058	NE	Conifer Savannah
24	Cliff	61	46	75	2085	NE	Conifer Forest
25	<u>Populus</u> spp.	18	15	83	1250	---	Grassland
26	Cliff	24	15	62	1951	E	Conifer Savannah
27	Cliff	91	76	83	2073	NE	Conifer Savannah
28	Cliff	30	23	75	2073	E	Conifer Forest
29a	Cliff	43	30	71	1738	SE	Conifer Savannah
29b	Cliff	30	12	40	1738	NE	Conifer Savannah
30a	Cliff	91	76	83	2134	E	Conifer Savannah
30b	Cliff	122	53	44	2012	E	Conifer Savannah
30c	Cliff	46	27	60	2043	NE	Conifer Savannah
31a	Cliff	76	24	32	2073	NE	Conifer Savannah
32a	Cliff	46	24	53	1890	NE	Conifer Savannah
32b	Cliff	61	14	22	1860	E	Conifer Savannah
32c	Cliff	61	52	85	1890	E	Conifer Savannah
33a	Cliff	61	38	62	1944	N	Conifer Forest
33b	Cliff	61	46	75	1951	N	Conifer Forest
33c	Cliff	30	24	80	1951	E	Conifer Forest
34a	Cliff	76	70	92	1951	NE	Conifer Forest
34b	Cliff	91	84	92	1951	N	Conifer Forest
35	Cliff	15	14	90	1311	S	Grassland
36	Cliff	91	79	87	2256	NE	Conifer Savannah
37	Cliff	24	9	37	1982	SE	Conifer Savannah
38	<u>Pseudotsuga</u>	11	6	57	1631	N	Conifer Savannah
39	Cliff	27	12	44	2134	NE	Conifer Savannah
40	Cliff	27	15	56	2134	SE	Conifer Savannah
41a	Cliff	122	76	62	1707	S	Conifer Savannah
41b	Cliff	107	76	71	1707	S	Conifer Savannah
42a	Cliff	12	9	75	1268	E	Agricultural
42b	Cliff	12	8	62	1268	E	Agricultural
42c	Cliff	12	6	50	1268	E	Agricultural
43	Cliff	30	9	30	2165	NE	Conifer Savannah
44a	Cliff	122	76	62	2061	E	Conifer Savannah
44b	Cliff	91	61	67	2012	E	Conifer Savannah
45a	Cliff	61	30	50	1695	SE	Conifer Savannah
45b	Cliff	38	30	80	1695	NE	Conifer Savannah
45c	Cliff	61	15	25	1683	NE	Conifer Savannah
46a	Cliff	122	61	50	1768	E	Conifer Savannah
46b	Cliff	122	15	12	1723	E	Conifer Savannah
47a	Cliff	46	27	60	2122	E	Conifer Savannah
47b	Cliff	46	27	60	2104	E	Conifer Savannah
48	Cliff	30	21	70	1966	S	Conifer Savannah
49a	Cliff	61	30	50	1841	E	Conifer Savannah
49b	Cliff	38	15	40	1720	E	Conifer Savannah
50a	Cliff	6	5	80	1409	W	Grassland
50b	Cliff	6	5	80	1384	SW	Grassland

Appendix H. (continued)

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
51	Cliff	6	4.6	75	1402	S	Grassland
52	Cliff	24	12	50	1921	NE	Conifer Savannah
53a	Cliff	46	24	53	1982	SE	Conifer Savannah
53b	Cliff	61	30	50	1982	NE	Conifer Savannah
54a	Cliff	61	38	62	1616	E	Conifer Savannah
54b	Cliff	61	43	70	1622	E	Conifer Savannah
55	Cliff	24	9	38	1890	E	Conifer Savannah
56a	Cliff	30	9	30	1573	SE	Conifer Savannah
56b	Cliff	30	15	50	1585	E	Conifer Savannah
57	Cliff	61	53	88	1598	NE	Conifer Savannah
58	Cliff	61	30	50	1677	N	Conifer Savannah
59	Cliff	46	30	67	2061	SE	Conifer Savannah
60a	Cliff	76	24	32	2146	N	Conifer Forest
60b	Cliff	76	30	40	2220	NE	Conifer Forest
61	Cliff	122	61	50	2317	E	Conifer Forest
62	Cliff	61	38	62	2146	N	Conifer Forest
63	Cliff	21	14	64	1982	SE	Conifer Savannah
64	Cliff	30	18	60	2195	NE	Conifer Savannah
65a	Cliff	46	30	67	2104	NE	Conifer Savannah
65b	Cliff	27	15	56	2098	N	Conifer Savannah
66a	Cliff	30	21	70	1982	NE	Conifer Forest
66b	Cliff	30	18	60	1921	E	Conifer Forest
67	Cliff	76	46	60	2061	NE	Conifer Savannah
68	Cliff	46	24	53	2165	S	Conifer Savannah
69	Cliff	61	55	90	2000	SE	Conifer Savannah
70	Cliff	46	18	40	2024	E	Conifer Savannah
MEAN =		67.2	38.1	57.6	1905.6		
SD =		49.63	30.23	17.50	260.77		
RANGE =		6-244	4.6-152	12-92	1250-2386		

Appendix I. Prey species observed in the diets of five raptor species on the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

Prey Species	Raptor Species				
	Golden Eagle	Swainson's Hawk	Ferruginous Hawk	Prairie Falcon	Great Horned Owl
<u>Bartramia longicauda</u>				X	
<u>Falco sparverius</u>					X
<u>Dendragapus obscurus</u>					X
<u>Tympanuchus phasianellus</u>		X			
<u>Perdix perdix</u>		X			
<u>Columba livia</u>					X
<u>Eremophila alpestris</u>					X
<u>Pica pica</u>					X
<u>Turdus migratorius</u>				X	
<u>Unidentified sparrow</u>					X
<u>Sturnella neglecta</u>		X	X	X	X
<u>Unidentified blackbird</u>		X			X
<u>Unidentified bird</u>	X				
<u>Sylvilagus spp.</u>		X			
<u>Lepus townsendii</u>	X		X		X
<u>Marmota flaviventris</u>			X		
<u>Spermophilus richardsonii</u>		X	X		X
<u>Spermophilus columbianus</u>		X			X
<u>Spermophilus spp.</u>	X			X	
<u>Thomomys talpoides</u>					X
<u>Peromyscus maniculatus</u>					X
<u>Microtus spp.</u>		X			X

Appendix I. (continued)

Prey Species	Raptor Species				
	Golden Eagle	Swainson's Hawk	Ferruginous Hawk	Prairie Falcon	Great Horned Owl
<u>Ondatra zibethicus</u>					X
<u>Mustela nivalis</u>					X
<u>Odocoileus hemionus</u> (fawn)	X				
Unidentified snake		X			X
<u>Catostomus spp.</u>					X
Crayfish					X
Grasshopper		X			X
Beetle					X

Appendix J. Nest-site characteristics of red-tailed hawk nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1	<u>Populus</u> spp.	9.1	6.1	67	1287	---	Riparian
2	Cliff	9.1	6.1	67	1287	NE	Grassland
3	<u>Populus</u> spp.	9.1	6.1	67	1232	---	Riparian
4	<u>Populus</u> spp.	12.2	9.1	75	1268	---	Riparian
5	<u>Populus</u> spp.	10.7	4.6	43	1299	---	Riparian
6	<u>Populus</u> spp.	6.1	4.9	80	1293	---	Riparian
7	<u>Populus</u> spp.	9.1	7.6	83	1274	---	Riparian
8	<u>Populus</u> spp.	6.1	4.6	75	1427	---	Riparian
9	<u>Populus</u> spp.	10.7	7.6	71	1262	---	Riparian
10	<u>Populus</u> spp.	6.1	4.6	75	1274	---	Riparian
11	<u>Populus</u> spp.	10.7	7.6	71	1280	---	Riparian
12	<u>Populus</u> spp.	7.6	6.1	80	1305	---	Riparian
13	<u>Populus</u> spp.	10.7	7.6	71	1250	---	Riparian
14	<u>Populus</u> spp.	10.7	7.6	71	1201	---	Riparian
15	<u>Populus</u> spp.	15.2	13.7	90	1250	---	Riparian
16	<u>Populus</u> spp.	10.7	9.1	86	1616	NE	Conifer Forest
17	Cliff	9.1	6.1	67	1829	S	Conifer Savannah
18	Cliff	30.5	7.6	25	1463	E	Conifer Savannah
19	<u>Populus</u> spp.	13.7	12.2	89	1311	---	Riparian
20	Cliff	4.6	3.0	67	1366	NW	Grassland
MEAN = 10.6			7.1	71.0	1338.7		
SD = 5.36			2.56	14.95	148.85		
RANGE = 4.6-30.5			3.0-13.7	25-90	1201-1829		

Appendix K. Nest-site characteristics of Swainson's hawk nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1a	<u>Populus</u> spp.	7.6	6.1	80	1189	---	Grassland
1b	<u>Populus</u> spp.	2.4	1.8	75	1201	---	Grassland
2	<u>Salix</u> spp.	2.7	2.1	78	1378	---	Riparian
3	<u>Prunus</u> spp.	4.6	3.0	67	1317	---	Riparian
4a	<u>Populus</u> spp.	6.1	3.0	50	1323	---	Grassland
4b	<u>Fraxinus</u> spp.	4.6	3.0	67	1323	---	Grassland
5	<u>Prunus</u> spp.	3.0	2.4	80	1378	NW	Grassland
6	<u>Populus</u> spp.	9.1	7.6	83	1183	---	Riparian
7	<u>Salix</u> spp.	?	?	?	1250	---	Riparian
8	<u>Salix</u> spp.	3.7	3.0	83	1305	---	Riparian
9	<u>Populus</u> spp.	3.0	1.8	60	1207	---	Riparian
10	<u>Populus</u> spp.	6.1	4.6	75	1232	---	Riparian
11	<u>Populus</u> spp.	9.1	8.2	90	1219	---	Riparian
12	<u>Populus</u> spp.	6.1	5.5	90	1171	---	Riparian
13	<u>Populus</u> spp.	4.6	3.3	73	1152	---	Riparian
14	<u>Populus</u> spp.	10.7	9.1	86	1238	---	Riparian
15	<u>Populus</u> spp.	9.1	6.1	67	1226	---	Riparian
16	<u>Populus</u> spp.	4.6	3.7	80	1268	---	Riparian
17	<u>Populus</u> spp.	12.2	9.1	75	1219	---	Riparian
18	<u>Populus</u> spp.	10.7	6.1	57	1171	---	Riparian
19	<u>Populus</u> spp.	6.1	4.6	75	1256	---	Riparian
20	<u>Populus</u> spp.	9.1	7.6	83	1262	---	Riparian
21	<u>Populus</u> spp.	9.1	6.1	67	1189	---	Grassland
22	<u>Salix</u> spp.	2.4	2.1	87	1177	---	Riparian
23	<u>Prunus</u> spp.	1.8	1.8	100	1335	---	Riparian
24	<u>Populus</u> spp.	7.6	6.1	80	1177	---	Riparian
25	<u>Populus</u> spp.	9.1	7.6	83	1165	---	Riparian
26	<u>Prunus</u> spp.	3.0	1.8	60	1360	---	Grassland
27	<u>Populus</u> spp.	?	?	?	1238	---	Riparian
28	<u>Prunus</u> spp.	2.4	1.5	62	1335	---	Agricultural
29	<u>Prunus</u> spp.	3.0	1.8	60	1311	---	Riparian
30	<u>Populus</u> spp.	13.7	7.3	53	1378	N	Grassland

MEAN = 6.2 4.6 74.2 1254.2

SD = 3.32 2.48 12.07 71.12

RANGE = 1.8-13.7 1.5-9.1 53-100 1152-1378

Appendix L. Nest-site characteristics of ferruginous hawk nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1a	Ground	---	---	---	1317	W	Grassland
1b	Ground	---	---	---	1329	W	Grassland
1c	Ground	---	---	---	1414	S	Grassland
1d	Ground	---	---	---	1292	E	Grassland
2a	Ground	---	---	---	1250	W	Agricultural
2b	Ground	---	---	---	1250	W	Agricultural
3a	Ground	---	---	---	1402	N	Grassland
3b	Ground	---	---	---	1372	E	Grassland
4a	Cliff	4.6	4.0	87	1250	NW	Grassland
4b	Cliff	4.6	4.0	87	1250	NW	Grassland
4c	Cliff	4.6	4.0	87	1250	W	Grassland
5	Cliff	6.1	3.7	60	1244	N	Grassland
6	Cliff	3.0	3.0	100	1384	SW	Grassland
7a	Ground	---	---	---	1237	S	Grassland
7b	Ground	---	---	---	1237	N	Grassland
8a	Ground	---	---	---	1225	N	Grassland
8b	Ground	---	---	---	1225	N	Grassland
8c	Ground	---	---	---	1225	N	Grassland
9	Ground	---	---	---	1372	S	Grassland
10a	Ground	---	---	---	1372	W	Grassland
10b	Ground	---	---	---	1311	N	Grassland
10c	Ground	---	---	---	1311	S	Grassland
10d	Ground	---	---	---	1311	N	Grassland
10e	Ground	---	---	---	1311	N	Grassland
10f	Ground	---	---	---	1311	N	Grassland
10g	Ground	---	---	---	1341	S	Grassland
10h	Ground	---	---	---	1341	NW	Grassland
10i	Ground	---	---	---	1372	W	Grassland
11	Cliff	2.7	2.1	78	1304	N	Grassland
12	Cliff	3.0	2.4	80	1280	NW	Grassland
13a	Ground	---	---	---	1341	N	Grassland
13b	Ground	---	---	---	1341	N	Grassland
14	Ground	---	---	---	1390	NE	Grassland

MEAN = 1307.9

SD = 57.71

RANGE = 1225-1414

Appendix M. Nest-site characteristics of prairie falcon nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

	HEIGHT SUPPORT	HEIGHT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1	76		72	95	1634	E	Conifer Savannah
2	91		61	67	1646	NE	Conifer Forest
3	61		?	?	2158	W	Conifer Savannah
4	122		91	75	1585	SE	Conifer Savannah
5	61		9	15	1549	E	Riparian
6a	122		98	80	1817	NE	Conifer Forest
6b	152		114	75	1817	NE	Conifer Forest
7a	46		12	26	1890	SW	Conifer Savannah
7b	49		26	53	1805	SE	Conifer Savannah
8	122		61	50	1829	NE	Conifer Forest
9	46		23	50	1683	E	Conifer Savannah
10	122		76	62	2158	E	Conifer Forest
11	183		91	50	1817	S	Conifer Savannah
12	30		9	30	1707	N	Conifer Savannah
13	122		91	75	1890	NE	Conifer Savannah
14	91		76	84	1951	SE	Conifer Forest
15	30		18	60	2030	E	Conifer Savannah
16	61		15	25	1921	NE	Conifer Savannah
17	30		18	60	1646	NE	Conifer Savannah
18	46		27	59	1854	NE	Conifer Savannah
19	61		43	70	1921	NE	Conifer Forest
20	76		64	84	1890	NE	Conifer Savannah
21	30		15	50	1905	E	Conifer Forest
22	152		107	70	1951	E	Conifer Savannah
23	61		?	?	2012	NE	Conifer Forest
24	91		?	?	2317	NE	Conifer Savannah
25	122		?	?	2134	E	Conifer Savannah
26	183		?	?	2195	SE	Conifer Savannah
27	152		76	50	2317	NE	Conifer Savannah
28	91		61	67	1768	E	Riparian
29	46		?	?	2165	E	Conifer Savannah
30	106		91	86	1890	NE	Conifer Forest
31	122		61	50	1829	NE	Conifer Savannah
32	183		152	83	1707	SW	Conifer Savannah
33	122		91	75	2030	NE	Conifer Forest
34	61		?	?	2043	SE	Conifer Savannah
35	6		5	83	1244	W	Grassland
36	9		7.6	83	1805	E	Conifer Savannah
37	24		12	50	2122	E	Conifer Savannah
38	76		67	88	1555	E	Conifer Savannah
39	61		30	50	1573	E	Conifer Savannah
40	152		?	?	2268	E	Conifer Savannah
41	182		?	?	2134	NE	Conifer Savannah
42	61		?	?	2232	NE	Conifer Savannah
43	9		3	33	1793	SE	Conifer Savannah
44	30		?	?	1829	NE	Conifer Savannah
45	76		46	60	1951	SE	Conifer Savannah
46	61		46	75	1921	NE	Conifer Savannah
47	24		12	50	1573	SE	Conifer Savannah
48	122		15	12	2195	SE	Conifer Savannah
49	46		40	87	1695	NE	Conifer Forest

Appendix M. (continued)

	HEIGHT SUPPORT	HEIGHT (m) NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
50	37	24	67	1787	NW	Conifer Savannah
51	46	?	?	1915	E	Conifer Forest
52	12	?	?	1677	NE	Conifer Savannah
53	91	?	?	2226	E	Conifer Savannah
54	46	?	?	2226	E	Conifer Savannah
55	30	?	?	2043	E	Conifer Savannah
56	61	?	?	1841	E	Conifer Savannah

MEAN =	79.0	50.2	61.3	1897.7		
SD =	48.86	36.90	20.76	227.06		
RANGE =	6-183	3-152	12-95	1244-2317		

Appendix N. Nest-site characteristics of great horned owl nests located along the Rocky Mountain Front, northcentral Montana, 1982 - 1984.

NEST NO.	NEST SUPPORT	HEIGHT SUPPORT (m)	HEIGHT NEST (m)	PERCENT HEIGHT	ELEVATION (m)	EXPOSURE	SURROUNDING HABITAT
1	Cliff	6.1	2.1	35	1280	S	Grassland
2	Abandoned Barn	4.6	2.7	60	1183	---	Grassland
3	Prunus	3.0	2.4	80	1372	NE	Grassland
4	Cliff	3.0	2.1	70	1427	NE	Grassland
5	Populus	9.1	4.6	50	1396	---	Riparian
6	Populus	12.2	9.1	75	1396	---	Riparian
7	Fraxinus	4.6	3.4	73	1293	---	Grassland
8	Populus	9.1	?	?	1274	---	Riparian
9	Populus	9.1	?	?	1256	---	Riparian
10	Populus	9.1	6.1	67	1195	---	Riparian
11	Populus	13.7	7.6	56	1317	---	Riparian

-							
X =	7.6	4.5	62.9	1308.1			
SD =	3.60	2.59	14.18	81.91			
RANGE =	3.0-13.7	2.1-9.1	35-80	1183-1427			

1951-1952